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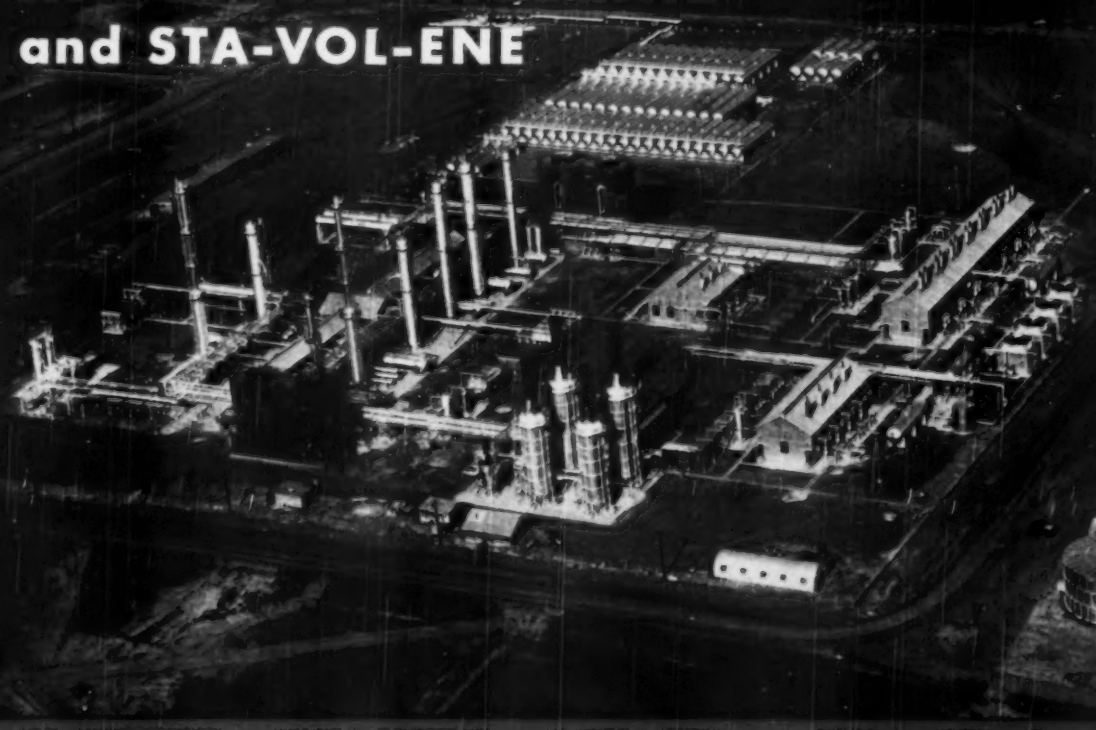

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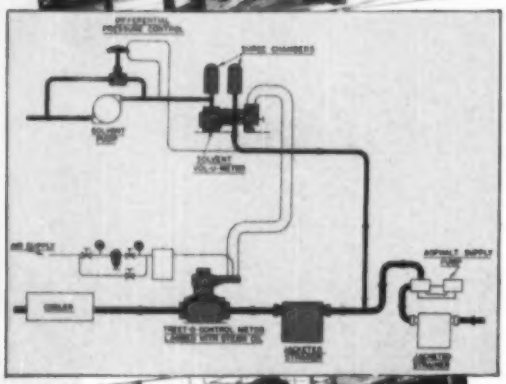

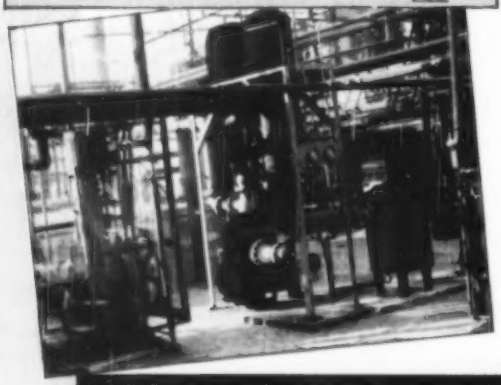

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Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

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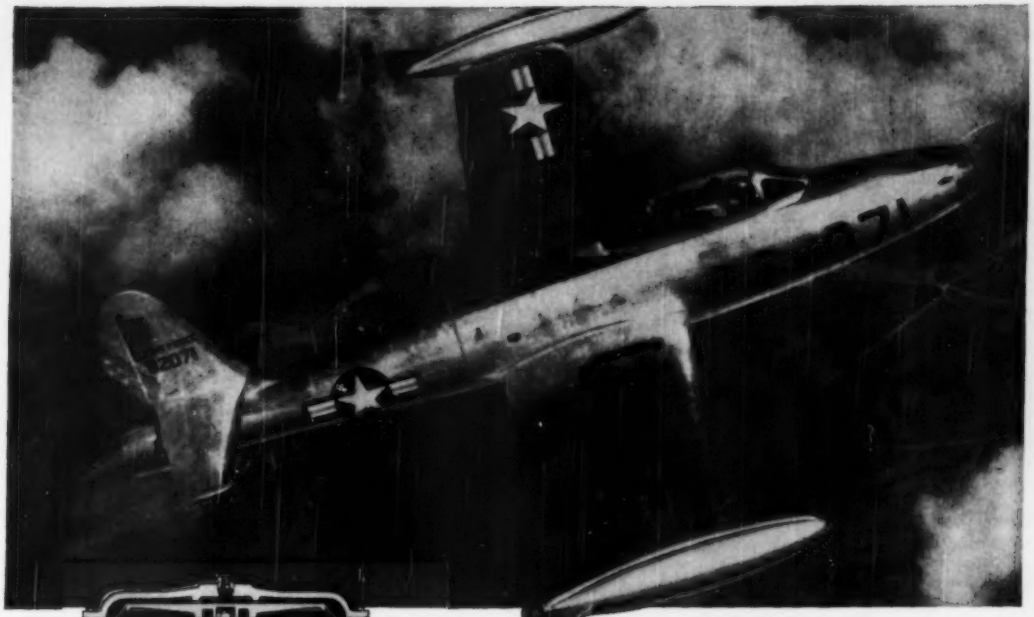

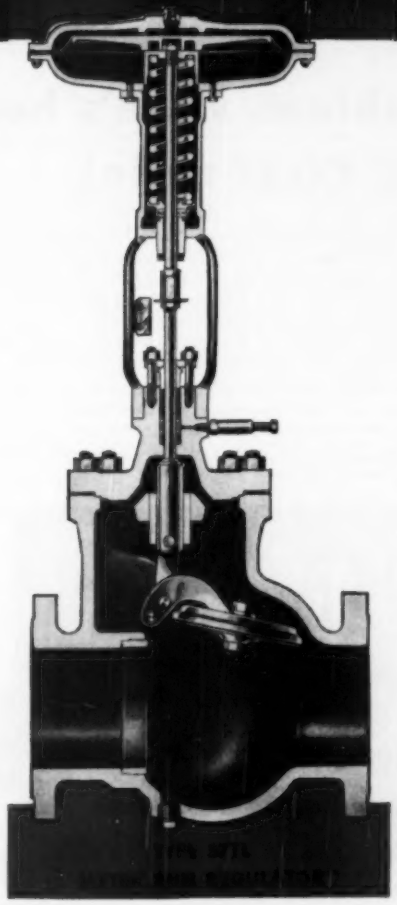

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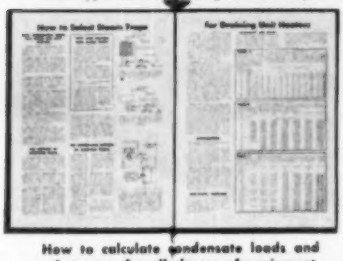

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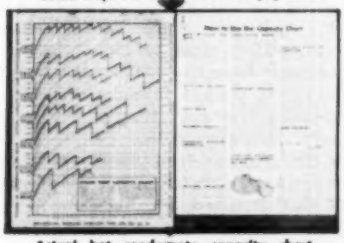

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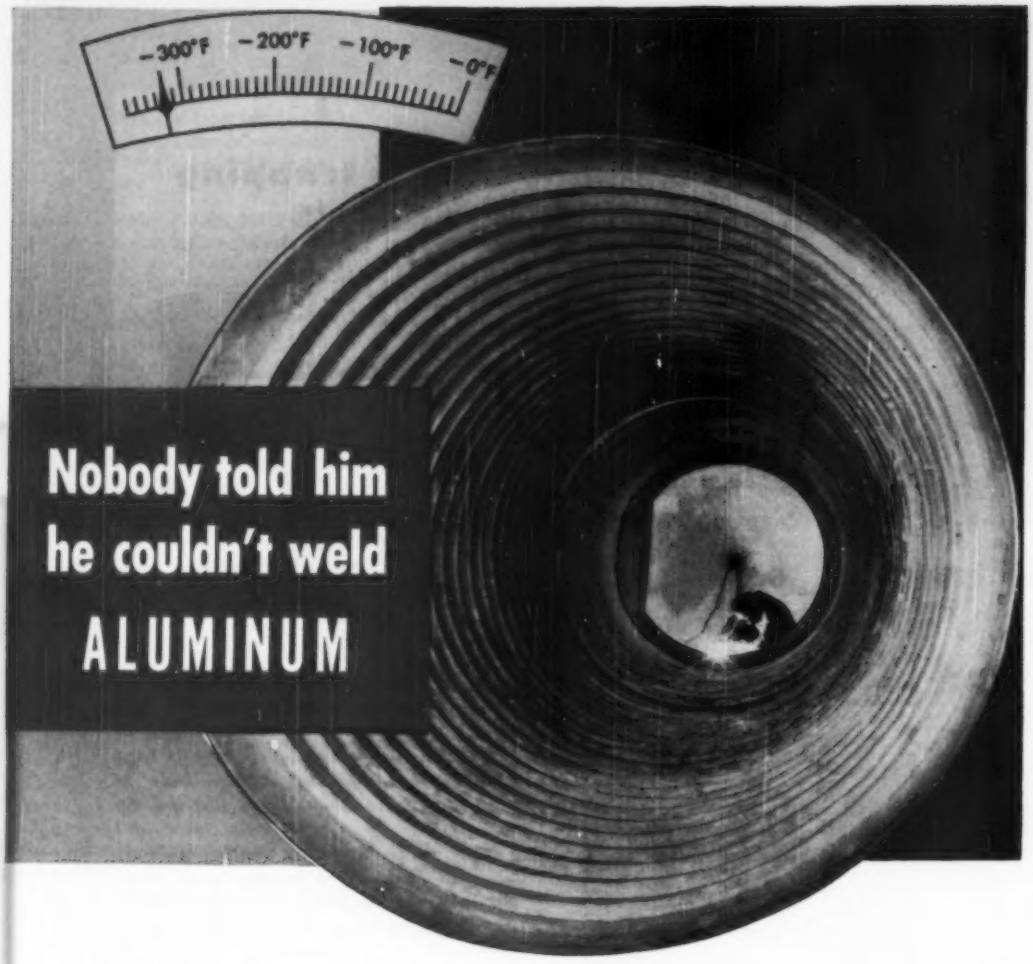

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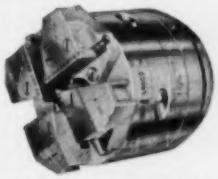

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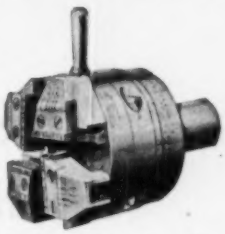

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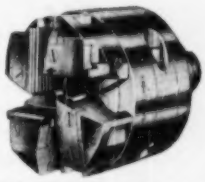

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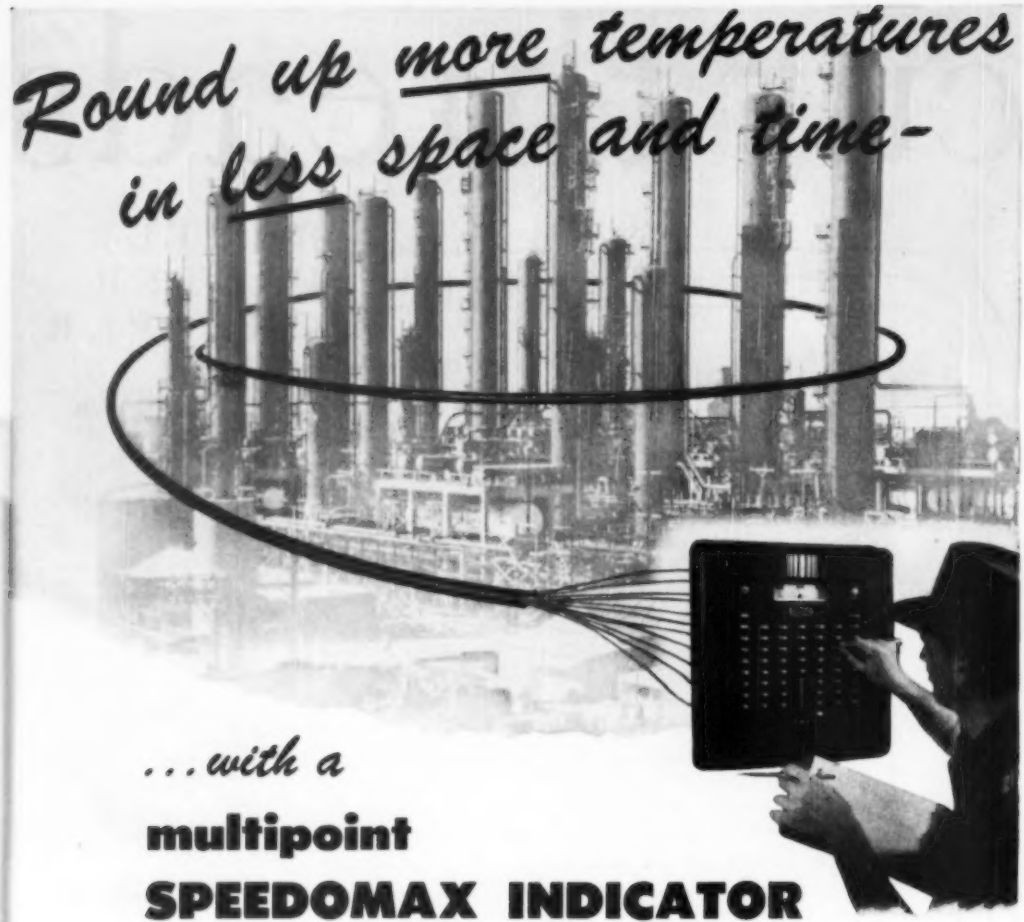

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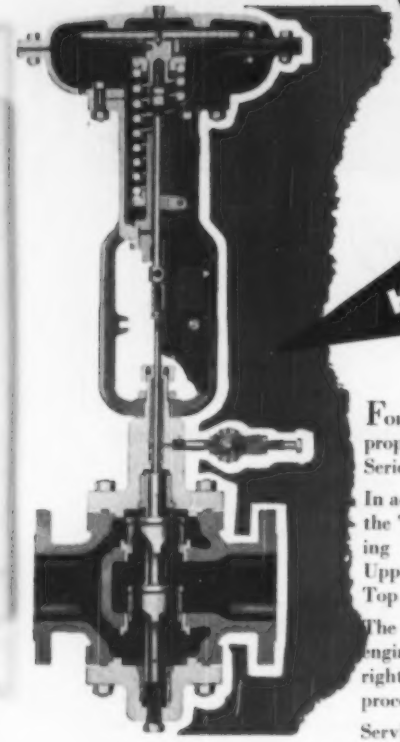

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GAS DISPERSION:
A Typical Process Handled *Better* with *Lightnin'* Mixers
(MIXCO Engineered)

This large mid-western producer of pharmaceuticals was unable to get satisfactory results with an air dispersion process . . . until he called in MIXCO engineers. Their research data and 25 years of experience showed him how to improve agitation and gas dispersion—how to obtain *vastly greater output . . . high product quality . . . better results than he had ever believed possible.*

The resulting installation of nine 50-horsepower LIGHTNIN Mixers has lived up to promises in every respect.

Your process, too, may need only a slight change in fluid agitation to operate at its best. If you are shooting for faster production, closer control, or reduced labor and upkeep costs, MIXCO can help you. Only MIXCO gives you the benefit of 25 years' fluid mixing experience . . . an impressive record of service to the process industries . . . backed by research data that enable you to *know in advance* the results you will get.

That's why MIXCO is glad to take *full responsibility* for the success of every installation of LIGHTNIN Mixers!

Check the processes you use or plan to use, and write us for facts on agitation that does what you want it to do. Write today. Your letter will receive prompt, courteous attention by MIXCO engineers.

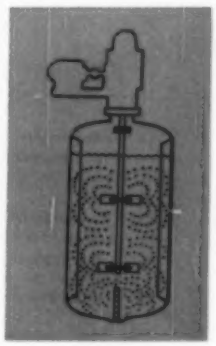
WHAT RESULTS DO YOU GET?

POOR

Poor results are obtained with open impellers, which allow gas to by-pass as large bubbles. Swirling liquid merely rotates in tank, causing a deep vortex with little or no mixing action. Impeller is incorrectly applied and does not break up gas bubbles. Low gas handling capacity and poor absorption are the result. A motor horsepower test shows almost as much horsepower drawn during gassing as in the ungassed liquid. Try this test on *your* gas dispersion agitation.

GOOD

A MIXCO-engineered installation. Proper baffling breaks up swirl, giving top-to-bottom turnover and intimate mixing. Disc-type turbine impeller, sized from exclusive MIXCO data, is taking hold of the gas and liquid . . . giving fine break-up of bubbles. Greater gas-liquid contact time permits higher gas flow rates and gives greatly increased production rates. The proof: horsepower consumption of the drive motor decreases considerably during gassing, in accordance with research data.



IT COULD BE *YOUR* PRODUCT

This MIXCO success story is typical of many in our files. If your process requires moving fluids within tanks, consult us. Typical problems we have helped customers solve include:

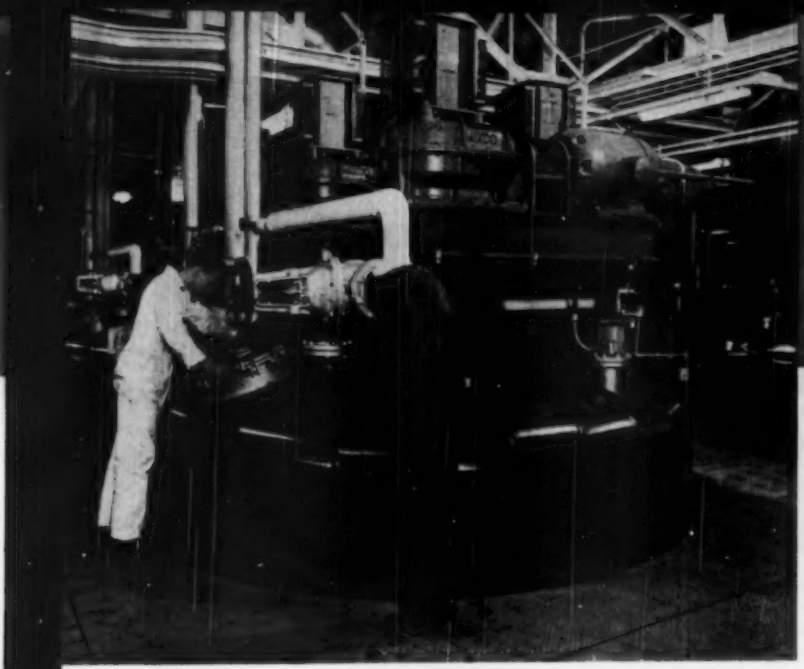
- Batch or Continuous Processing
- Blending
- Mixing
- Agitating
- Dissolving
- Extracting
- Contacting
- Solids Suspension
- Stripping
- Circulating
- Washing
- Reacting
- Crystallizing
- Process Control
- Gas Dispersion, Absorption
- Heat Transfer
- Emulsifying

A COMPLETE LINE . . . PLUS UNEXCELLED TECHNOLOGY

LIGHTNIN PORTABLE MIXERS
World's largest selling line of portable mixers. Electric or air motor; direct or gear drive. Capacities ½ to 5 HP. Send for Catalog S-75.

LIGHTNIN SIDE ENTERING MIXERS
For tanks up to 5 million gallons. Gear motor drive, Vee-belt drive and motorless types. Sizes 1 to 25 HP. Send for Catalog S-76.

LIGHTNIN TOP ENTERING AGITATORS
Turbine, propeller and paddle types. For open or closed tank service. Fixed or variable output speeds available in heavy duty drive, designed for ½ to 200 HP. Send for Catalogs S-89, S-78.



THREE 50-HP LIGHTNIN MIXERS (MIXCO engineered) give fine-bubble air dispersion and step up heat transfer in this 13,500-gallon tank.

APPLICATION DATA:

PROBLEM: Disperse air finely in mold broth to increase growth rate of a micro-organism producing an antibiotic.

COMPONENT	PCT. BY VOL.	SP. GR.
Antibiotic broth	4.8	1.0
Water	95.2	1.0

AIR FLOW RATE: Variable up to 600 CFM, depending on mold requirements.

AGITATION REQUIRED: Violent (Agitators have combined pumping capacity of 110,000 GPM).

TEMPERATURE: Close control required (efficient heat transfer). Start at 230° F. and gradually cool to 74° F.

PROCESS TIME: 96 hours continuous.

TANK DIMENSIONS: Three tanks, each 11'0" diameter, 17'6" straight side; dished top and bottom. Batch cooled by a single 4" helical coil 10' in diameter – 15 turns.

CAPACITY: 13,500 gals. **BATCH RATIO:** 0.74 (ungassed).

SOLUTION: MIXCO analysis showed greatest air-liquid contacting would be obtained by using *three* 50-HP mixers *in each tank*. Each unit was equipped with three 36" diameter multi-blade disperser turbines operating at 83 RPM, as selected for correct agitation by MIXCO's exclusive data on impeller design, proximity, and pumping capacity.*

Each tank was equipped with three baffles 15" wide, cut off 1 foot below liquid level.

The mixers were LIGHTNIN Model 7A WC-5000, mounted 3 to a tank (9 units in all), on 6' circle, spaced 120° apart.

RESULTS: Extremely fine bubble dispersion gives unprecedented high yields. High product stability and uniformity. Exceptionally trouble-free operation. Lower first cost and upkeep for the three LIGHTNIN Mixers (total 150 HP) than for a *single* competitive 125-HP unit. User well pleased with MIXCO installation.

**Note*—Had air flow rate been constant, larger size impellers could have been chosen, permitting even greater agitation. In this case, variable air flow made it a "must" to size the impeller for safe operation in *ungassed* liquid.

Check and mail coupon for further information on MIXCO engineering and LIGHTNIN Mixers and Agitators.

MIXING EQUIPMENT CO., Inc.
(MIXCO)
1064 GARSON AVENUE • ROCHESTER 9, N. Y.
IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

MIXING EQUIPMENT CO., INC.
1064 GARSON AVE., ROCHESTER 9, N. Y.

Please send me the literature checked:

- ☐ B-76 Side Entering Mixers
- ☐ B-78 Top Entering Mixers (Propeller Type)
- ☐ DH-50 Laboratory Mixers
- ☐ B-89 Top Entering Mixers (Turbine and Paddle Type)
- ☐ B-75 Portable Mixers (Electric and Air Driven)

Name .....

Title .....

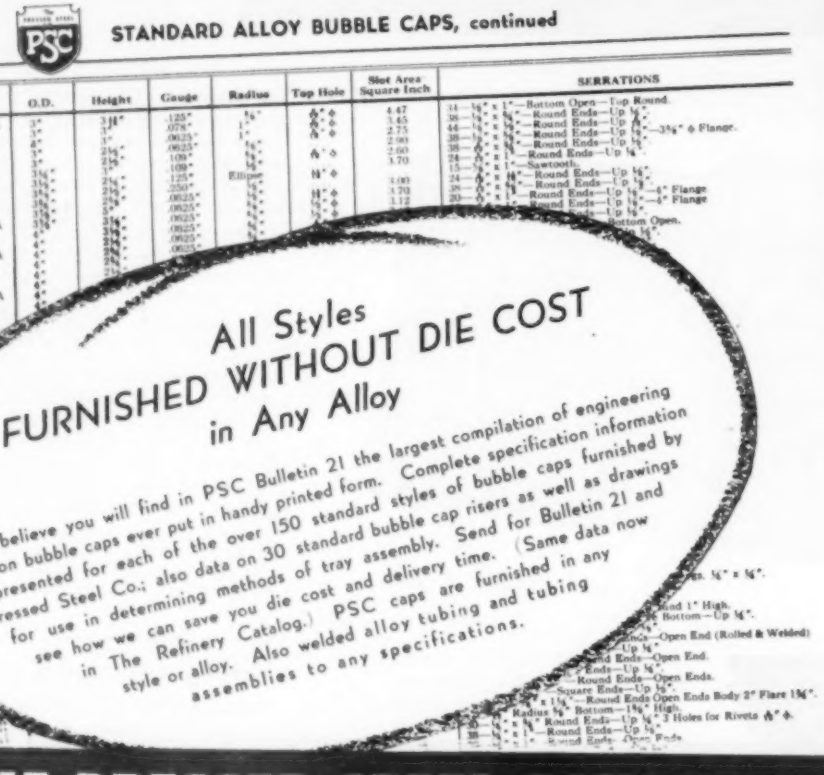
Company .....

Address .....

City ..... Zone ..... State .....

MEMO TO REFINERY ENGINEERS:

PSC Bulletin 21 LISTS COMPLETE DATA on over 150 STANDARD STYLES of Bubble Caps



STANDARD ALLOY BUBBLE CAPS, continued

No.	O.D.	Height	Gauge	Radius	Top Hole	Slot Area Square Inch	SERRATIONS
34A	3"	3 1/8"	.125"	3/16"	6 @ 1/4" ◇	4.47	11—1/4" x 1"—Bottom Open—Top Round.
35	3"	3"	.078"	1"	6 @ 1/4" ◇	3.65	36—1/2" x 3/4"—Round Ends—Up 1/4".
36	4"	3"	.0625"	1"	8 @ 1/4" ◇	2.73	44—1/2" x 3/4"—Round Ends—Up 1/4"—3 3/4" ◇ Flange.
38	4"	3"	.0625"	3/4"		2.00	28—1/2" x 3/4"—Round Ends—Up 1/4".
40	3"	2 1/2"	.109"	3/4"	4" ◇	1.60	38—1/2" x 3/4"—Round Ends—Up 1/4".
41	3"	2 1/2"	.109"	3/4"		3.70	24—1/2" x 3/4"—Round Ends—Up 1/4".
37	3 1/4"	3"	.109"	Ellipse	H" ◇		15—1/2" x 3/4"—Sawtooth.
39	3 1/4"	2 1/4"	.125"	3/4"		3.00	24—1/2" x 3/4"—Round Ends—Up 1/4".
39	3 1/4"	2 1/4"	.250"	3/4"		3.70	28—1/2" x 3/4"—Round Ends—Up 1/4"—4" Flange
45	3 1/4"	2 1/4"	.0625"	3/4"	H" ◇	3.12	20—1/2" x 3/4"—Round Ends—Up 1/4"—4" Flange
45	3 1/4"	2 1/4"	.0625"	3/4"	1/2" ◇		—Round Ends—Up 1/4".
46A	3 1/4"	3 1/4"	.0625"	3/4"			—Bottom Open.
47	4"	3 1/4"	.0625"	3/4"			—Up 1/4".
48	4"	3 1/4"	.0625"	3/4"			
46A	4"	3 1/4"					
49	4"	3 1/4"					
50	4"	3 1/4"					
51	4"	3 1/4"					
51A	4"	3 1/4"					
52	4"	3 1/4"					
53	4"	3 1/4"					
54	4"	3 1/4"					

All Styles
FURNISHED WITHOUT DIE COST
in Any Alloy

We believe you will find in PSC Bulletin 21 the largest compilation of engineering data on bubble caps ever put in handy printed form. Complete specification information is presented for each of the over 150 standard styles of bubble caps furnished by Pressed Steel Co.; also data on 30 standard bubble cap risers as well as drawings for use in determining methods of tray assembly. Send for Bulletin 21 and see how we can save you die cost and delivery time. (Same data now in The Refinery Catalog.) PSC caps are furnished in any style or alloy. Also welded alloy tubing and tubing assemblies to any specifications.

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Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

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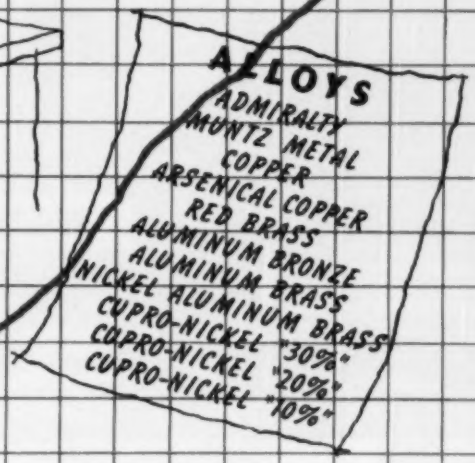
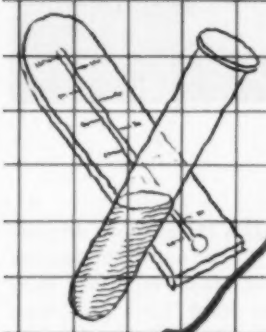
LET'S BE TECHNICAL

Trained technical people are always at your command to consult on any development problem you may have. Constant research is going on all the time in order to be as helpful as we can and have ready for you the answers to any questions you may ask us.





There is a proper alloy for each purpose. The choice depends upon the nature of the fluids or gases to be encountered. Our engineers can help you immeasurably in specifying the exact alloy you should employ under any given conditions.

We can help you with the diagnosis of your heat transfer problems—discuss with you such factors as temperatures, kinds of liquids and gases and their rates of flow, as they affect efficiencies in your operations.

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CONSERVATION AT WORK
for GREAT LAKES PIPE LINE COMPANY
Sioux Falls, S. D., Terminal. Three Graver Expansion Roof Tanks manifolded to 27 Graver cone roof tanks.

A story of a job well done . . .

●Several years ago, Graver built petroleum products tankage systems manifolded with Expansion Roof Tanks for the Great Lakes terminals at Sioux City and Des Moines, Iowa; Watertown and Sioux Falls, S. Dak., and Alexandria, Minn.

So satisfactory was the service of the Graver Expansion Roof Tanks that Great Lakes Pipe Line Co. included Expansion Roof Tanks in the specifications for its $55,000,000 expansion program.

The new Graver installations include five 80,000-barrel Expansion Roof Tanks at Minneapolis, four 55,000-barrel Expansion Roof Tanks at Omaha.

Graver installations at Des Moines (one 40,000-barrel Expansion Roof Tank and four 40,000-barrel cone roof tanks) and at Mankato, Minn. (one 40,000-barrel Expansion Roof Tank and three 40,000-barrel cone roof tanks) will be additions to present manifolded systems. Each of these Expansion Roof Tanks will have a 10-foot lift.

This repeat business speaks for itself—a tribute to Great Lakes' progress and testimony to Graver engineering. Ask for case histories on performance and vapor savings with Graver Expansion Roof Tanks. Write now!

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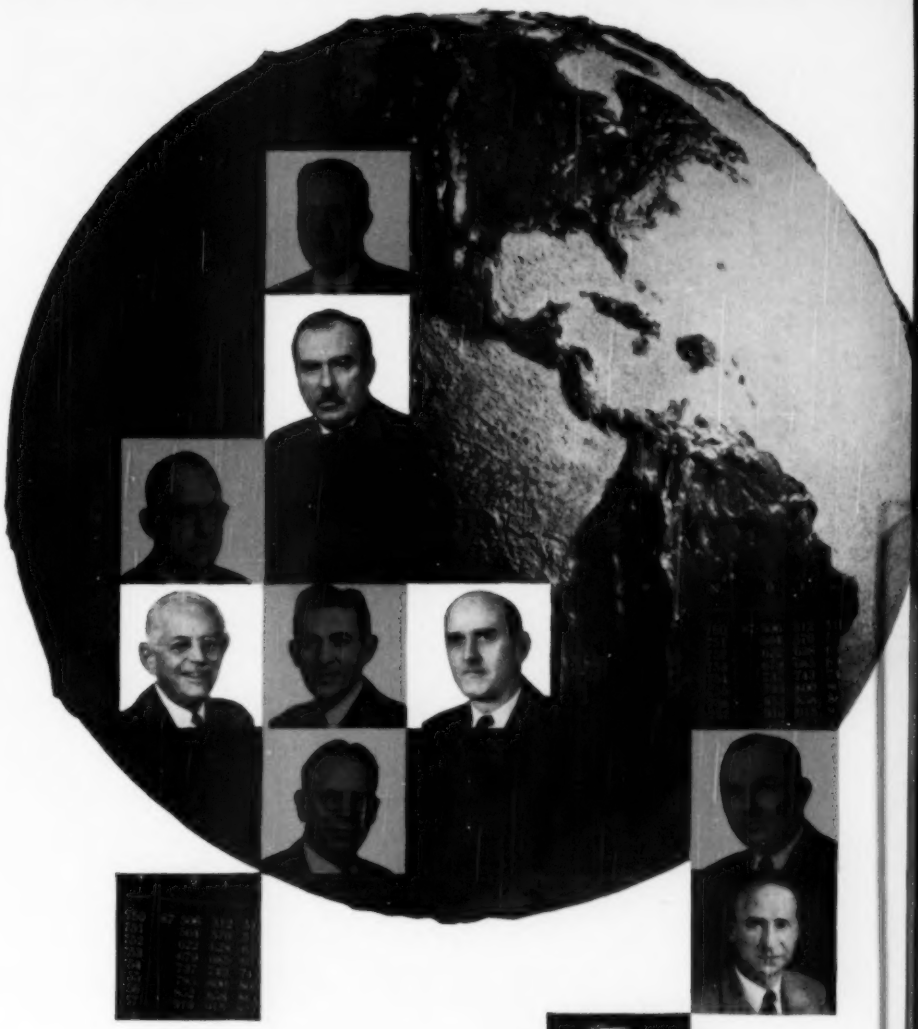


in project engineering

look to these Lummus men for worldwide performance

turn page . .

The Lummus man

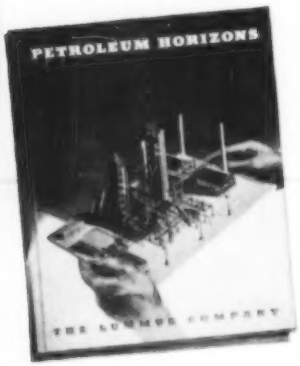
engaged in project engineering has a well diversified background of practical experience. Directly from a mechanical course at college, he entered the petroleum field and acquired his early experience with an oil company, either in the Engineering Department or in the Operating Department. He joined Lummus approximately 15 years ago, where his experience was extended covering all phases of engineering from laboratory, through design and planning to actual field construction. Concurrently keeping abreast of developments, he has maintained his standing as a licensed professional Engineer.

In his wide field of project engineering are included many of the world's outstanding refinery installations as well as petroleum chemical units.

The Lummus Project Engineer is "at home" with operations in foreign fields. He has a broad knowledge of the unique problems encountered in Europe, the Near East, India, the Orient, Latin America, and Canada, as well as those which confront him in the U. S. A. Project Construction in isolated locations present unusual difficulties in connection with problems of water supply, water disposal, housing facilities, personnel, etc., problems which the Lummus Engineer has handled successfully.

Your Project at Lummus will receive the attention of those Engineers whose experience will best fulfill your specific needs. Frequent requests by customers for reassignment of the same Engineers for "repeat" jobs is the best evidence of their competence.

Now ready—1950 book of Petroleum Processes



This new eighty page book describes the latest process developments in petroleum refining.

Detailed descriptions and flow charts of more than thirty refinery processes are featured. Photographic techniques are employed to assist you to visualize units. Send for your copy—today

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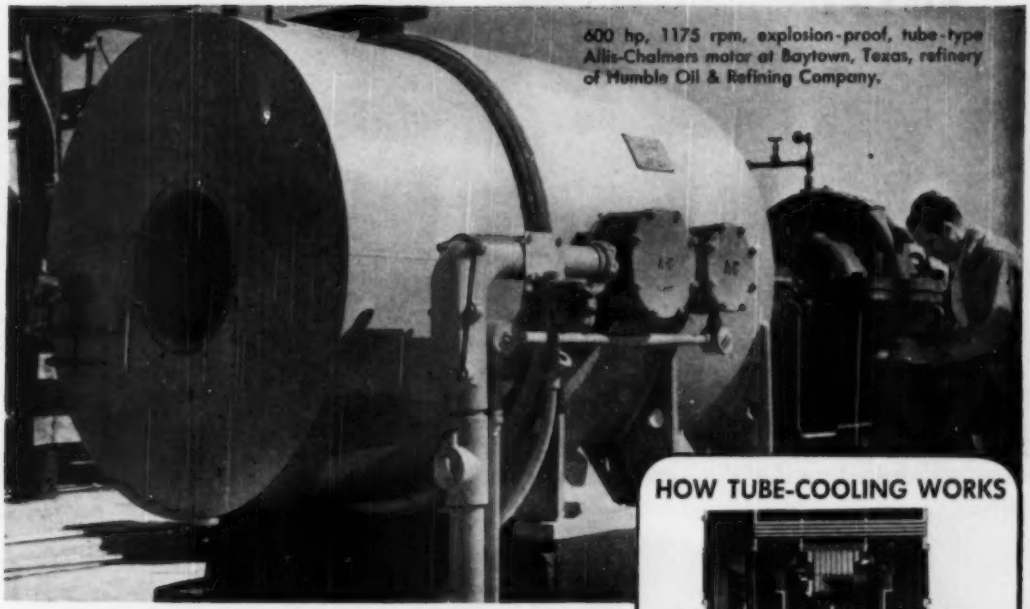
STRAIGHT FLOW OF AIR MAKES TUBE-TYPE TEFC* MOTORS

Self-Cleaning



600 hp, 1175 rpm, explosion-proof, tube-type Allis-Chalmers motor at Baytown, Texas, refinery of Humble Oil & Refining Company.

*TEFC MEANS—*Totally Enclosed, Fan Cooled*

YOU CAN GET THE SAME PROTECTION against explosive vapors in refinery and allied operations that Humble Oil & Refining company gets with its Allis-Chalmers tube-type motors.

This *new* type of motor is self-cleaning. Cooling air flows through straight, smooth tubes. There are no recesses to collect moisture and dirt as in conventional designs. Heat exchanger type of cooling reduces weight of the motor. The tube-type design has been adapted to the most severe corrosive conditions found in refineries or chemical plants.

It is now available with Underwriters Laboratories' label from 125 to 800 hp, 3570 rpm, with corresponding ratings at lower speeds.

For more information, get Bulletins 51R7149 and 05B7150.

A-3028

ALLIS-CHALMERS, 1062A SO. 70 ST.
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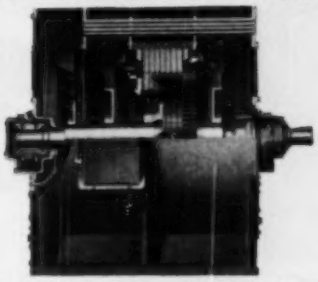
HOW TUBE-COOLING WORKS



1. Efficient air flow combined with large heat transfer area for quick heat removal. 2. Free from dirt and moisture collecting obstructions. 3. *Internal* fans circulate inside air for rapid heat dispersal. 4. *External* fan blows cooling air through tubes. 5. All electrical parts completely enclosed for maximum protection from dirt and corrosive atmospheres.

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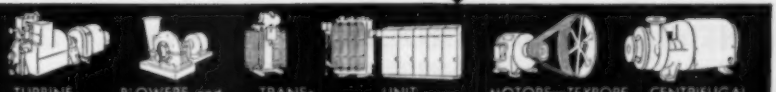

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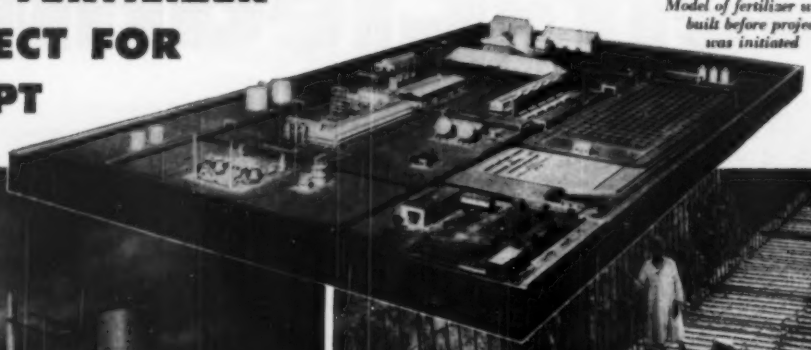
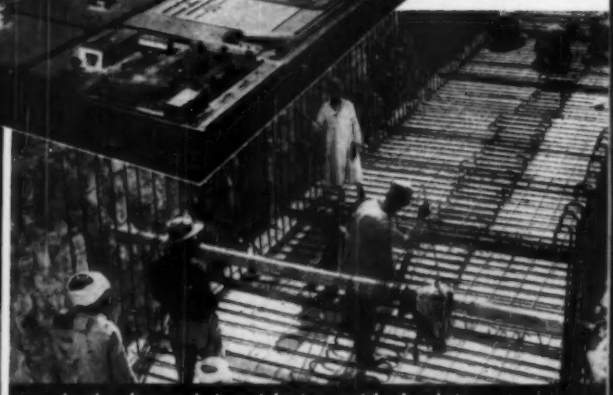
Progress Report by Chemico

LARGE FERTILIZER PROJECT FOR EGYPT



Model of fertilizer works built before project was initiated

Gas reformers to convert refinery gas to hydrogen and nitrogen



Local craftsmen placing reinforcing steel for foundations

Nitric acid absorption towers and ammonia storage tanks

General view of the project which covers an area of 1350 acres

These photographs show work in progress on the 550-ton per day fertilizer plant being built at Suez, Egypt. This important Chemico project includes plants for the production of synthetic ammonia, nitric acid and calcium nitrate together with complete facilities for supplying utilities such as power and water to the various units. This is one of a number of world-wide Chemico activities which include projects in Formosa, India, Mexico, South Africa and Brazil. Whatever your problem may be in the production of heavy chemicals ... wherever it may be ... you can be sure that Chemico will deliver a highly efficient plant on a guaranteed-performance basis.

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Chemico Plants are Profitable Investments

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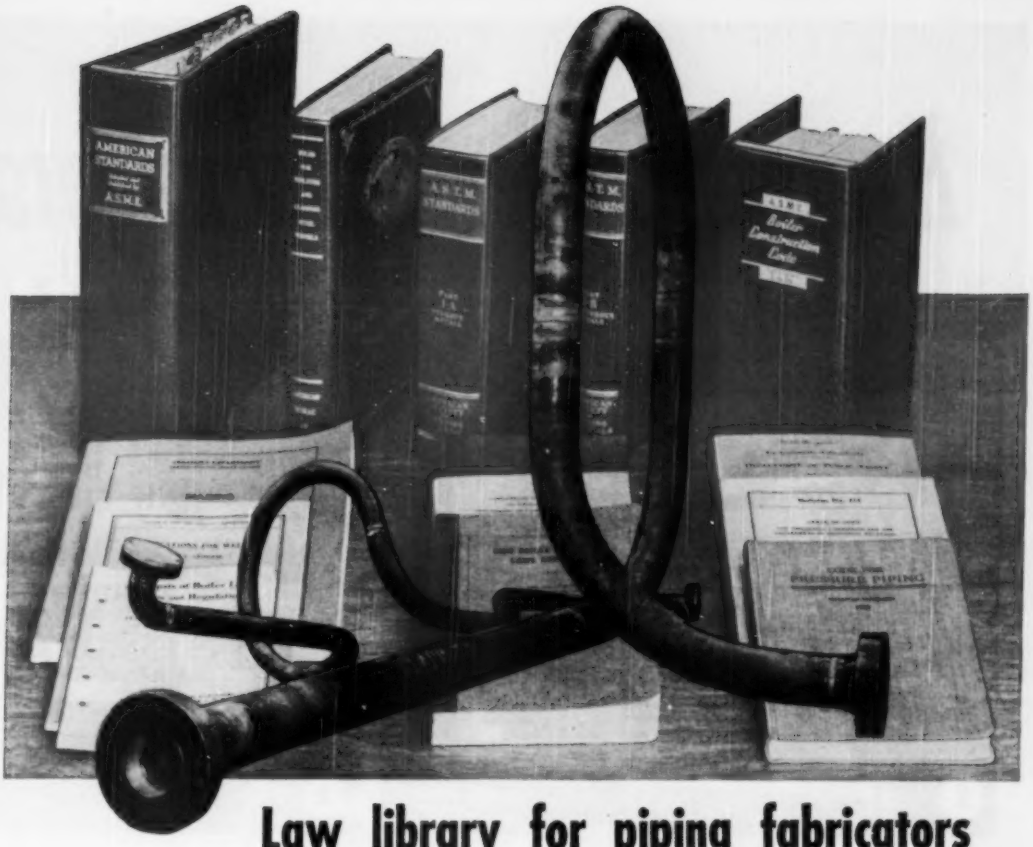

Law library for piping fabricators

THE safety of your employees, the welfare of the community and a major investment can depend on a single piece of prefabricated piping. That's what piping codes are for . . . state, national, association and insurance codes. You don't have to know these codes because Grinnell engineers know the "law" intimately, check and cross-check with these codes at every step from preparation of detailed drawings and specifications right through bending, welding, stress relieving, heat treating, testing, final inspection, assembly and test runs.

That's just one of the many advantages of having a piping system prefabricated by Grinnell.

The complete "package" includes interpretative engineering, metallurgical research, compliance with code requirements, manufacturing drawings and specifications, production schedules, purchase of materials, specialized facilities, skilled personnel, control of quality and rigid inspection.

You get this complete package from a Grinnell prefabricated piping plant on schedule, ready for field erection, meeting all code requirements and at a real economy.

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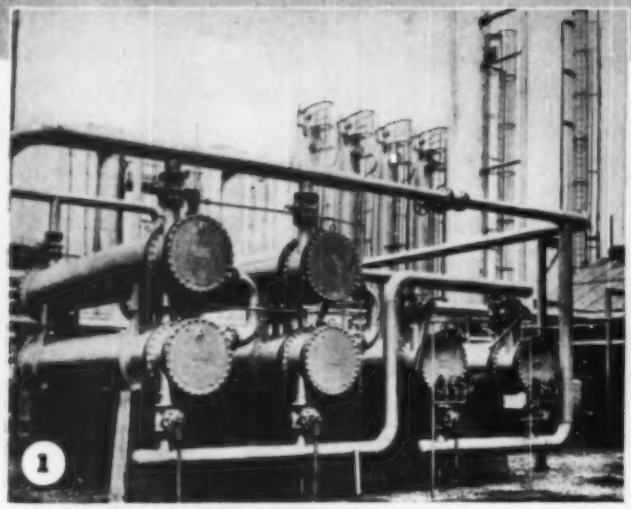
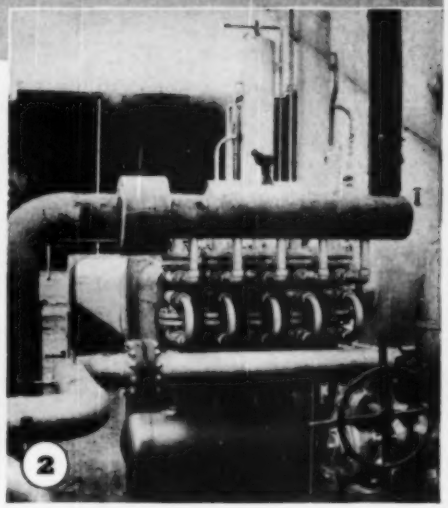
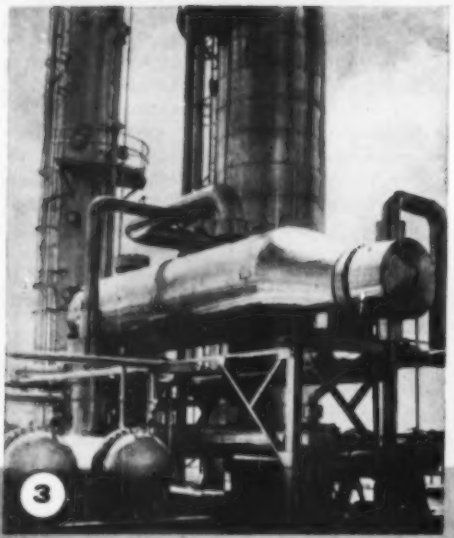
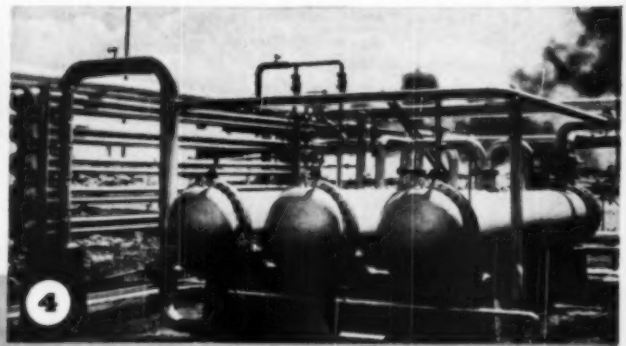








1. 6 G-R Tubular Exchangers handling glycol-amine on both shell and tube sides
2. 10 G-R Twin Bare Pipe Section Regeneration Gas Heaters
3. G-R Solution Reboiler, and G-R Tubular Secondary Exchangers
4. 10 G-R Twin G-Fin Section Primary Exchangers, and 3 G-R Tubular Secondary Exchangers

GRISCOM-RUSSELL • PIONEERS IN HEAT TRANSFER APPARATUS

Reboilers...all G-R

The El Paso Natural Gas Company has so many installations of G-R Heat Transfer apparatus that a complete list would be difficult to compile.

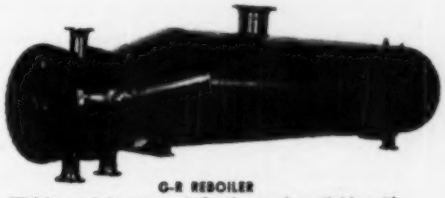
However, the accompanying photographs, taken at random at Jal, New Mexico, indicate the wide range of services for which the Company uses G-R apparatus. The illustrated G-R units include Twin G-Fin Section Primary Exchangers, Type FST Tubular Secondary Exchangers, a G-R Solution Reboiler, and Twin Bare Pipe Regeneration Gas Heaters.

This company, like so many others throughout the oil and gas industry, has evidenced its satisfaction with G-R Heat Transfer Apparatus in the most unequivocal and convincing manner — by wide use and by repeat orders.

You, too, can be assured of satisfactory service from heat transfer apparatus by standardizing on G-R. When doing so, you get the benefit of the unequalled G-R experience, the extensive variety of G-R designs, and the long-proven merit of G-R apparatus. Whatever may be your heat transfer needs . . . condensing, cooling, heating or heat exchange . . . be sure to consult the G-R engineers for their authoritative advice.

G-R TUBULAR EXCHANGER
A shell-and-tube unit with many distinctive features for efficient performance with minimum attendance and maintenance expense.

G-R TWIN G-FIN SECTION
The "universal" standard interchangeable heat transfer unit with longitudinally-finned elements. More than 40,000 installed sections.



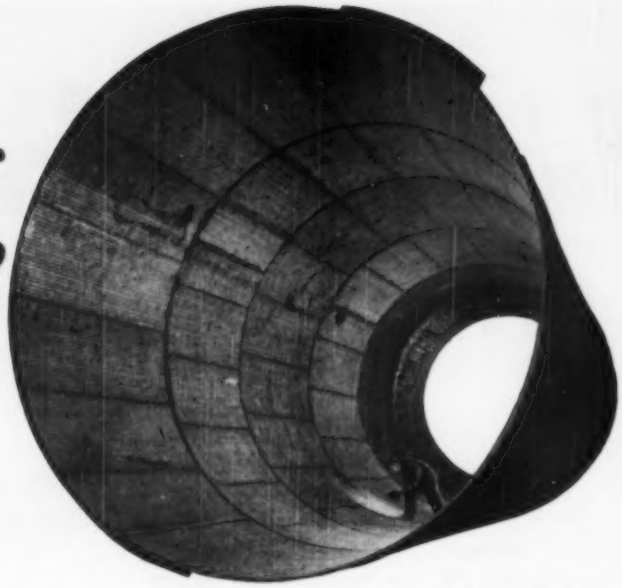
G-R REBOILER
Widely used in process industries, and available with either bare tubes or K-Fin helically finned elements.

THE GRISCOM-RUSSELL CO., 285 MADISON AVE., NEW YORK 17, N. Y.

GRISCOM-RUSSELL

GR 250

Worried about HCl corrosion?



Monel-lined top section of a large fractionating column. Made by the A. O. Smith Corporation for one of the nation's largest oil refiners.

Let MONEL help you keep costs down

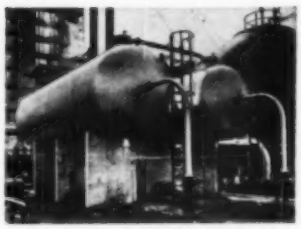
Many years of service experience backed by extensive research, have shown that Monel® has satisfactory resistance to destructive corrosion by hydrogen chloride and hydrochloric acid.

In applications where low concentrations of hydrochloric acid must be handled regularly, Monel vessels and processing equipment have given outstanding service. In petroleum refining, for example, Monel-lined fractionating columns, tanks, and Monel piping and fittings have substantially outlasted other metals.

In addition, Monel is an excellent structural material, possessing high strength, and good workability. Monel can be welded to form corrosion-resistant joints; can be machined, formed, and bent with ordinary shop tools and methods.

Monel is available in all standard mill forms, including seamless tubing and Monel-Clad Steel sheet and plates.

If you have corrosion problems and are looking for ways to preserve product purity or cut maintenance expense, you are invited to consult our Corrosion Engineering Service. Write, explaining your difficulties, and we will put at your disposal a vast accumulation of research and experience data.



Monel-lined tanks installed at the plant of a large Southern oil refiner. Tanks are lined with Monel to combat corrosive action of dilute hydrochloric acid.

The tanks were fabricated by Wyatt Metal & Boiler Works, Houston, Texas.

EMBLEM OF SERVICE

NICKEL INCO TRADE MARK **ALLOYS**

MONEL® • "K"® MONEL • "R"® MONEL • "KR"® MONEL • NICKEL • "D"® NICKEL • "L"® NICKEL INCONEL® • DURANICKEL® • PERMANICKEL® INCONEL "X"®.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

NOW—Simpler, Faster, Automatic Titrations!

Here's another new Beckman advancement in instrumentation—an instrument that runs your titrations for you. It's the Beckman Automatic Titrator—the instrument that makes accurate titrations more rapidly and conveniently than by manual methods.

SIMPLE OPERATION: In a series of titrations, simply fill the burette, place the sample in the beaker—and the Beckman Automatic Titrator takes over from there. Raising the beaker holder into position automatically starts the stirrer motor and begins delivering titrating solution into the sample.

A special circuit electrically anticipates the approaching end point, scaling down delivery of the titrating solution in progressively smaller increments to assure a highly accurate titration. When the end point is reached, delivery of the titrating solution stops and a light shows completion of the titration—*all automatically and without attention from the operator.*

Whether your laboratory is large or small the Beckman Automatic Titrator provides important advantages in your titrating operations . . .

- *It releases the technician during titration, enabling him to perform other operations such as preparing samples, or calculating results.*
- *It eliminates the fatigue caused by close observation required in manual procedures.*
- *It gives objective, reproducible results . . . eliminates errors due to personal factors.*
- *It provides time-saving conveniences for sample handling.*

PERFORMS A WIDE VARIETY OF TITRATIONS—**Neutralization, Oxidation-Reduction, Precipitation, Complex-Formation and other types.**

NO SPECIAL TRAINING IS REQUIRED—**rapid and accurate titrations can readily be performed without special skill or technique.**

QUICK, SIMPLE OPERATION—**completes many routine titrations in only 1-1½ minutes—even titrations to 0.1% accuracy in 2½ minutes or less. Change of sample is simple, rapid—a single motion raises, locates and secures new sample in operating position.**

CONVENIENT, VERSATILE, ADAPTABLE—**0° to 100° C temperature compensation . . . adjustable holder accommodates 10 ml to 400 ml beakers or similar vessels . . . instrument may be used with all standard burettes down to 5 ml . . . as many as four delivery units accommodated by single amplifier control unit . . . uses standard Beckman electrodes . . . electrode holders and delivery tip can be pivoted into any required position . . . ample provision for mounting heating devices or other special equipment.**

ALSO A RELIABLE pH METER—**the Beckman Automatic Titrator can also be used as an AC-powered pH meter to give accurate readings over the range 0 to 14 pH, as well as millivolt readings from −600 to +1400 mv.**

For full details on this new Beckman instrument see your authorized Beckman dealer—or write direct. *Beckman Instruments, National Technical Laboratories, South Pasadena 25, California.*

Factory Service Branches:
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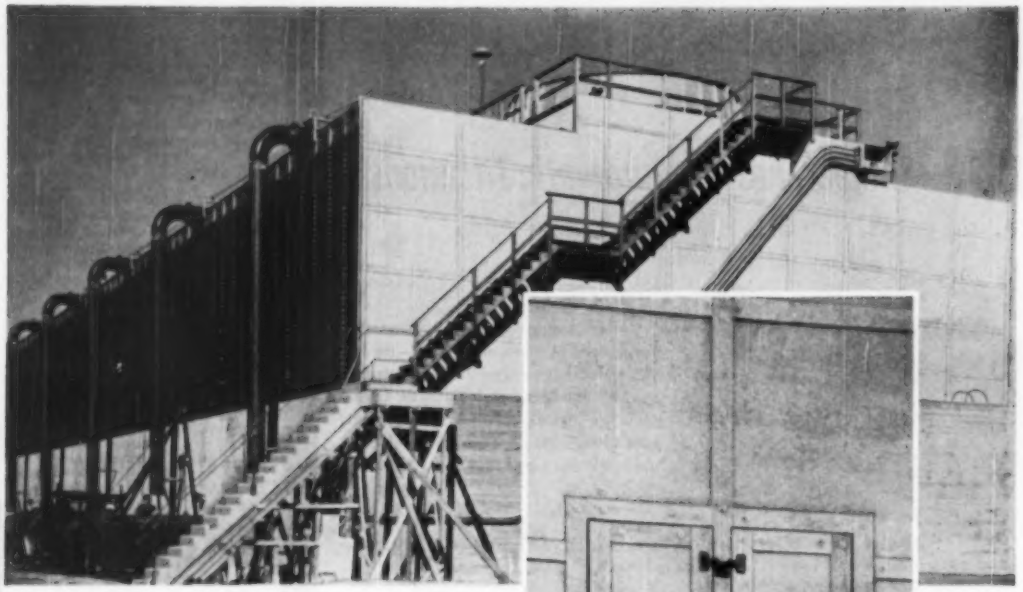
BECKMAN INSTRUMENTS
control modern industries

Beckman Instruments include: pH Meters and Electrodes — Spectrophotometers — Radioactivity Meters — Special Instruments



TWO-FISTED K&M "Century" APAC LICKS DOUBLE THREAT

Cooling tower temperatures on one side, plus Oklahoma weather on the other, don't bother the K&M APAC Asbestos-Cement Sheets on this job. Always, on any flat surfaces—large or small—outside or inside—K&M APAC is good for years of strictest economy.

APAC sections are large and strong, so that application is simple and quick. Thus erection time and labor costs are sharply reduced. Then comes lasting resistance to every changing season; to fire, rust, rot, rodents and termites. You couldn't have stronger assurance of minimum maintenance. You won't even need painting to preserve the neat, tough APAC surfaces.

For name of your nearest distributor, and all particulars, write to us.

"Century" ¼" thick APAC ASBESTOS-CEMENT SHEETS were used on this cooling tower at the Mustang Plant of the Oklahoma Gas and Electric Co. Constructed by Marley Co., Inc., Kansas City, Kansas.

K&M APAC suits your needs...

Use it for any flat panels, partitions, sheathing, shaft casings, bins.

Cut it easily to any needed sizes, right on the job.

Apply it over steel or wood girts, wood studs, solid wood sheathing, insulation board.

APAC Standard Sheet Size: 4' x 8'. *Standard Thicknesses:* $\frac{3}{16}$", $\frac{1}{4}$", $\frac{3}{8}$".

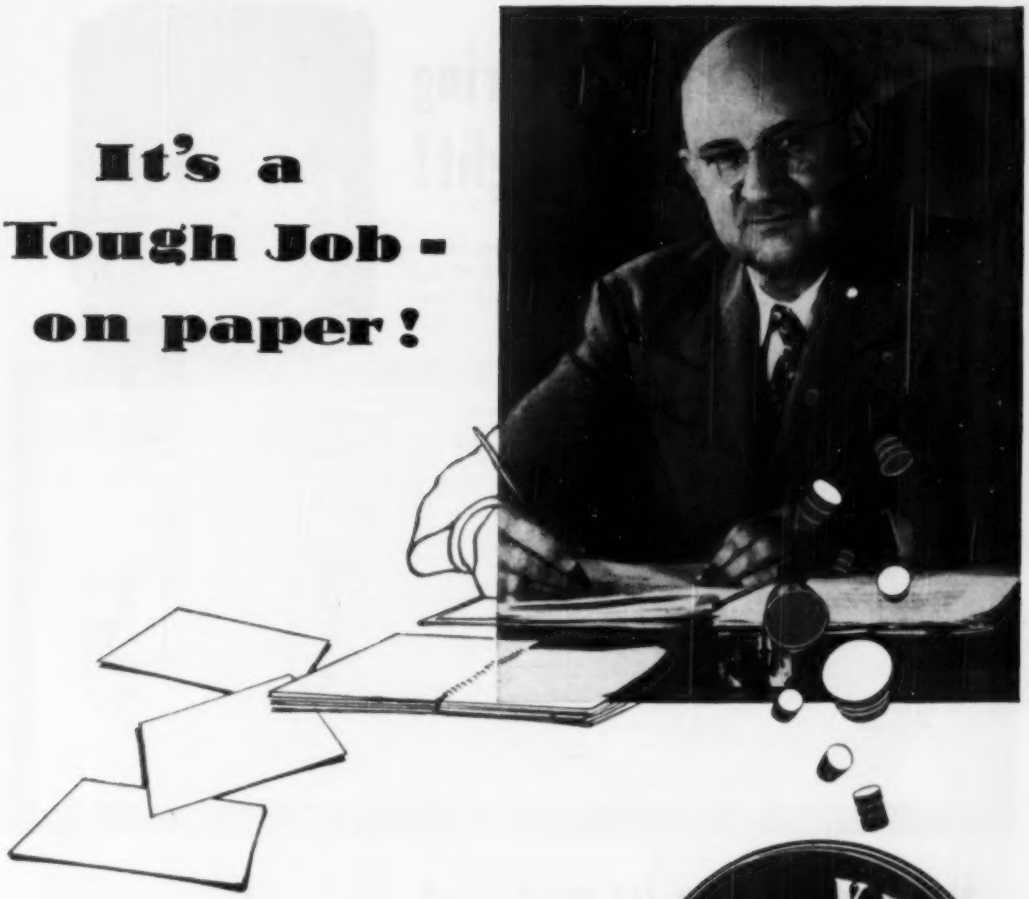
Nature made Asbestos...

Keasbey & Mattison has made it serve mankind since 1873.

K&M Lasts in Asbestos

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

It's a Tough Job - on paper!



VISCO 24-Hour Field Service is a tough job—on paper. Visco men are actually on call 24 hours a day to handle any oil field or refinery emergencies . . . *but*, we have found that where Visco Emulsion-Breakers are on the job, treating difficulties are so rare that Visco Field Service Men can almost always plan on a good night's sleep.

If your treating has been an all-hours headache, better switch to the blue Visco barrels . . . no knockout drops in them, but efficient, economical emulsion-breaker performance around the clock, year after year. Call Houston, CAPITOL 7300, collect, for Visco action, *now!*

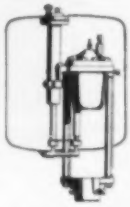
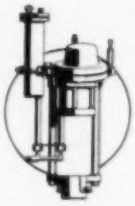
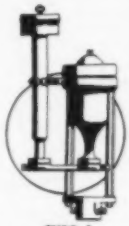
VISCO PRODUCTS COMPANY
INCORPORATED
City National Bank Building • Houston 2, Texas

Visco... **CONSISTENTLY EFFICIENT DEHYDRATING AND DESALTING CHEMICALS**

NOTICE: Visco Products Company is authorized to manufacture and sell Visco Oil Treating compounds for use in the breaking and resolving of oil emulsions, and to grant licenses for such use, under the following United States patents: 1,459,042; 1,466,443; 1,852,329; 1,897,289; 2,166,835; 2,260,990; 2,266,581; 2,314,783; 2,324,369; 2,360,454; 2,367,915; 2,368,686; 2,375,450; 2,375,451; Re. 20,331 and patents pending. Any purchaser of Visco Oil Treating compounds is authorized to use the same in the treating, breaking and resolving of oil emulsions in accordance with the above patents. The royalty for such use is included in the purchase price. Visco Products Company is authorized to and is willing to grant licenses on a royalty basis, to all companies, and to others desiring to practice the patented subject matter under any and all of the above patents, permitting the user to purchase the oil treating compounds at will from any vendor, and to prepare the compounds for use under the above patents or patents, at a royalty charge of 2c cents per gallon. Application for license should be made to Visco Products Company, Houston, Texas

What's worth metering is worth metering right!

. . . and Foxboro offers the *right* meter for every refinery measurement. See the typical applications below.

For Metering Steam to Stripper on a Stabilizing Unit	For Metering Air from a Blower	For Metering Reflux to Debutanizer in Light Ends Unit	For Metering Gas Oil to Storage in a Crude Unit	For Metering Charge to Reactor in a Poly Unit
				
TYPES 1 & 2 Meter Body light weight & low cost for indicators & portable recorders	**TYPE 9 Meter Body** for differential ranges as low as 1" H_2O – especially for low pressure gas and air service	**TYPE 17 Meter Body** unequalled quality meter for general refinery service	**TYPE 8 Meter Body** longest float travel, greatest power, highest accuracy meter ever built	**TYPE 6 Meter Body** leakproof measurement at really high pressures without compromise in accuracy

a flow meter type for every need

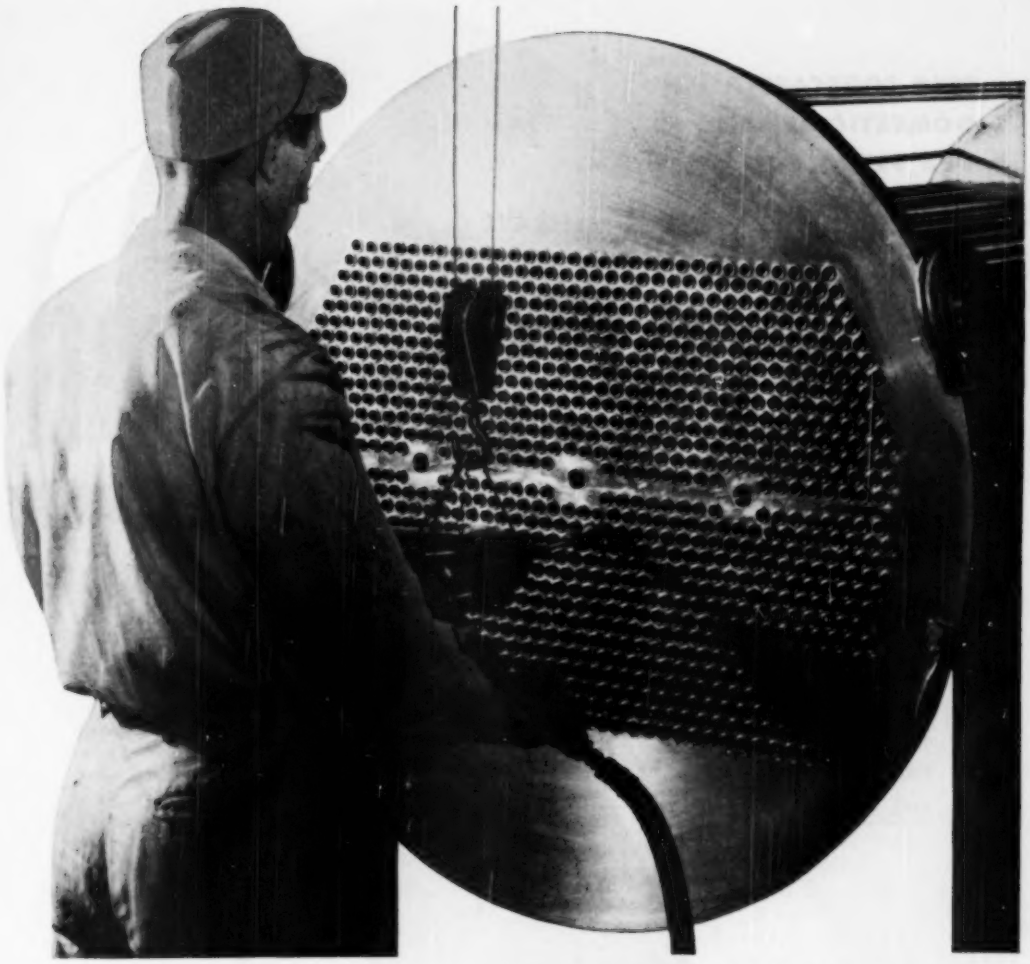
From its complete line of flow meters, Foxboro can offer *the best type* for virtually any metering problem . . . best in point of accuracy, dependability, and economy. There's a differential pressure range and static pressure rating to meet every requirement. Meters are available as indicators, recorders, controllers, and transmitters.

The widest selection of flow instruments is only one of many factors responsible for Foxboro's acknowledged leadership in flow metering. See how this factor — together with many superior, exclusive design features — give you most value for your money in flow metering. Write for Bulletin 351-2. **The Foxboro Company, 74 Neponset Avenue, Foxboro, Mass., U. S. A.**

Specifications of Foxboro Meter Types Illustrated

TYPE	MATERIAL	MAX. W. P.	RANGES
2	Forged Steel	1000	100"–200"
9	Cast Iron	150	2½"–10"
17	Forged Steel	1800	10"–400"
8	Forged Steel	1300	50"–400"
6	Forged Steel	3500	100"–200"

FOXBORO REG. U. S. PAT. OFF. **FLOW METERS**



RETUBING TOO OFTEN? . . . TRY

ELECTRUNITE® Stainless Steel Pressure Tubes

Ease of installation . . . long life . . . resistance to high temperatures and extreme corrosion . . . *all* good reasons why it pays to use Electrunite Pressure Tubes made of Republic Enduro Stainless Steel. Full range of analyses to meet every need.

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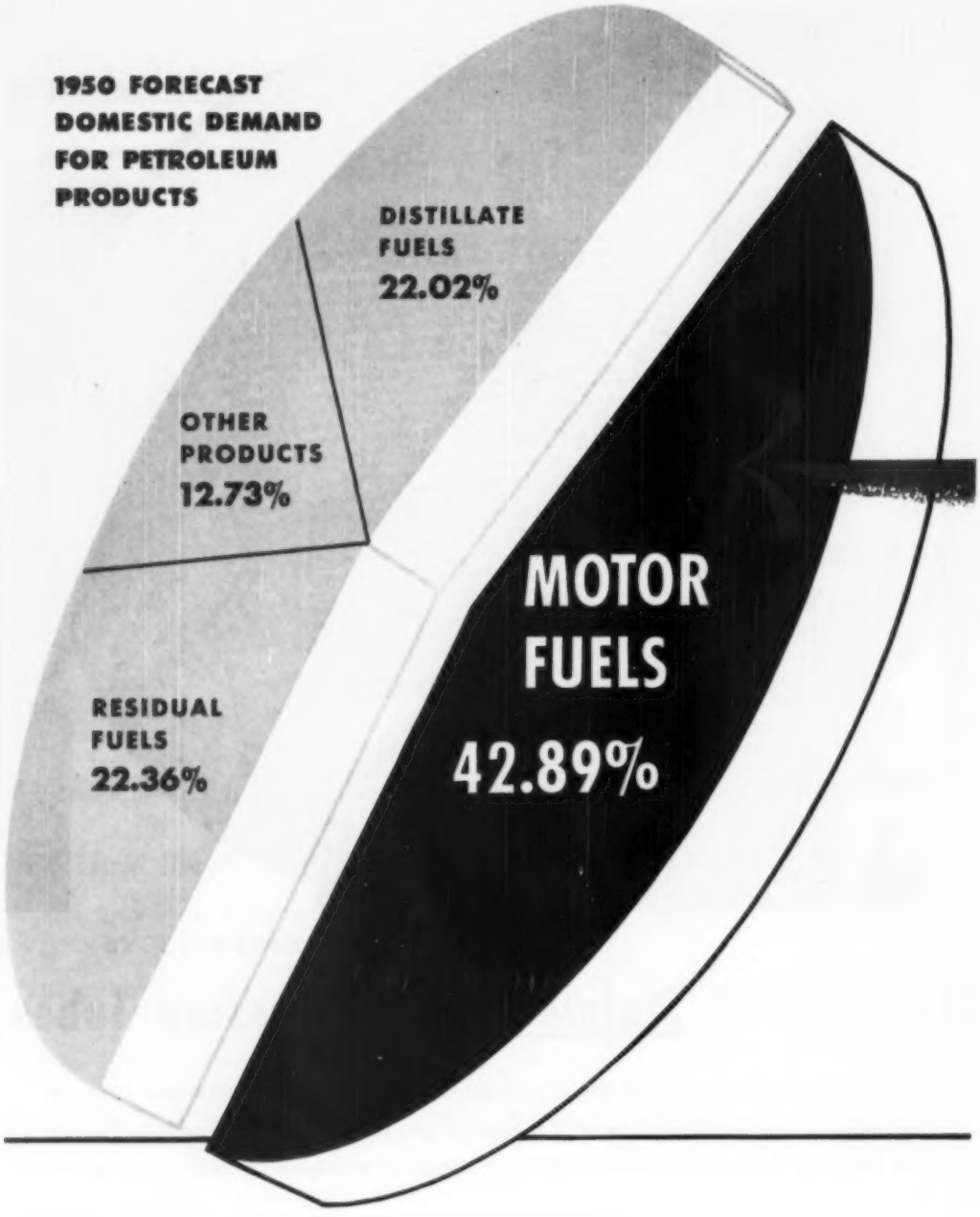
Republic
REPUBLIC STEEL
ELECTRUNITE
BOILER, SUPERHEATER AND HEAT EXCHANGER TUBES


1950 FORECAST
DOMESTIC DEMAND
FOR PETROLEUM
PRODUCTS
DISTILLATE
FUELS
22.02%
OTHER
PRODUCTS
12.73%
RESIDUAL
FUELS
22.36%
MOTOR
FUELS
42.89%

here's the market

FOR THE 11,640,000 GALLONS OF NATURAL AND RECYCLE GASOLINES THAT WILL BE PRODUCED EACH DAY IN 1950

More natural gas, more natural gasoline. At the same time, motor fuels are accounting for a greater and greater percentage of the overall demand for petroleum products. But how do you fit the increased amounts of finished gasoline and naphtha from your natural gasoline and recycling operations to this market when the demand is for products of higher and higher quality?

This is the answer: Up-grade these low research octane products with UOP's Platforming process . . . produce Platformate . . . and you have a motor fuel that meets *any* market requirement. No other process can up-grade low quality stocks as efficiently as Platforming. No other product has the high quality and superior performance of Platformate.

Platformates produced from natural gasoline and recycle naphthas have research and road-ratings of nearly 100 (with the addition of 3 cc. of lead). They are inherently stable and negligible in sulfur content. The odor is pleasant. There is more energy per gallon. And the Platforming process is economical . . . both in its initial investment and operating costs.

Investigate Platforming now. Up-grade your low quality natural gasoline and recycling products to a point where they meet any market requirement.

PLATFORMATE

PRODUCT OF THE PLATFORMING PROCESS, DEVELOPED AND LICENSED BY

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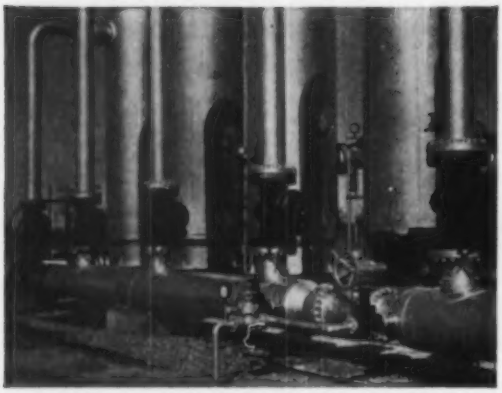
UOP

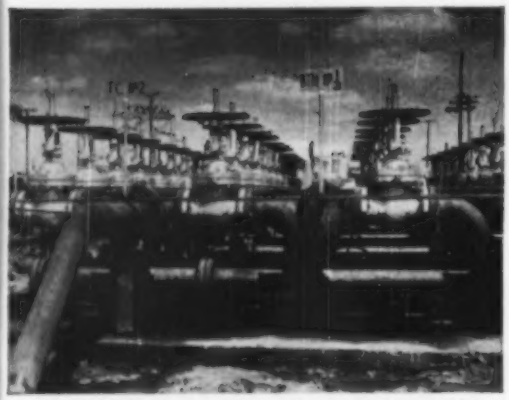
Laboratories:
RIVERSIDE, ILLINOIS

Universal Service Protects Your Refinery.

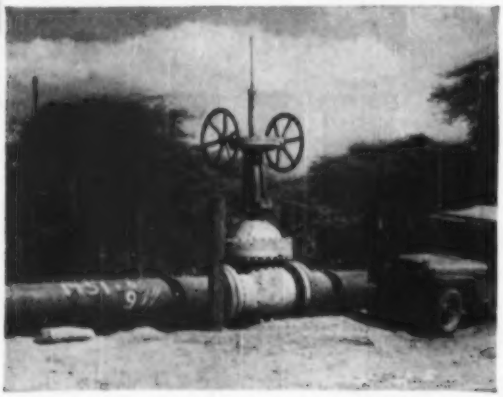
WALWORTH PIPE LINE VALVES...



Walworth 12-inch, steel, Lubricated Plug Valves on scrubbers in blower station yard of a southwestern pipe line company.



Walworth 8-inch, Series 600 Cast Steel, outside screw and yoke type, Pipe Line Gate Valves with stem protectors.



Walworth 26-inch, Series 600 Cast Steel, Pipe Line Valve with double handwheel operator in a South American pipe line.

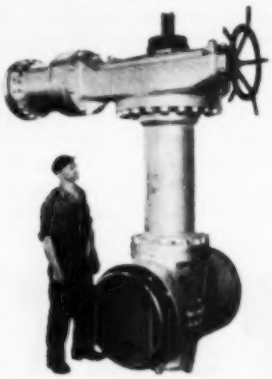
Walworth makes BOTH gate valves and lubricated plug valves for pipe line service

Walworth Pipe Line Valves are handling crude oil, fuel oil, gas, gasoline, and allied products in many of the most important pipe lines of the world. Their design is the result of years of experience in the production of valves to meet the particular requirements faced by the Oil and Gas Industry, in the distribution of its products through pipe lines.

Walworth Cast Steel Pipe Line Gate Valves and Cast Steel Horizontal Check Valves are accurately machined to close tolerances. They are produced for maximum cold working pressure, and have face-to-face and other dimensions in accordance with the current API standards. Discs of both Gate Valves and Check Valves open completely out of the passageway, allowing an unobstructed passage for scrapers or other tools.

Walworth Lubricated Plug Valves, because of the many advantages peculiar to the design of this type of valve, have gained wide acceptance in pipe line service, particularly on lines carrying natural or artificial gas and finished petroleum products.

Full information furnished upon request.



A Walworth 26 x 24-inch Lubricated Plug Valve for 960 pounds working pressure, with a high pressure cylinder for use in conjunction with automatic valve control. Built for natural gas pipe line service.

WALWORTH

valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

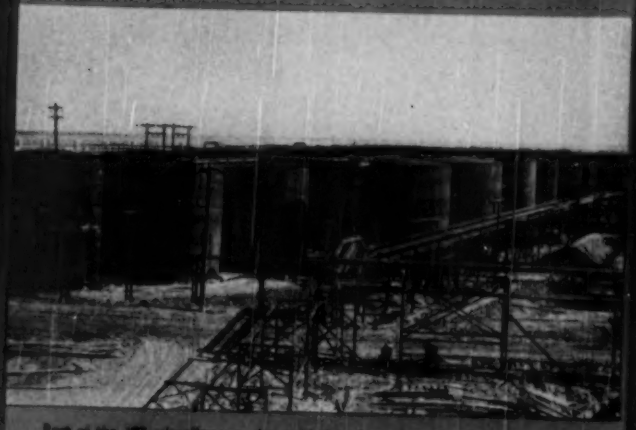
DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

ELLERBEE BROTHERS

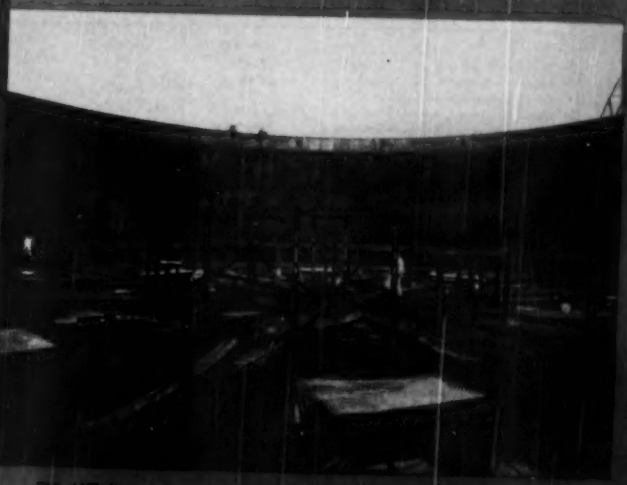
HAS NOW COMPLETED CONTRACTS FOR MOST OF THE MAJOR OIL AND CHEMICAL COMPANIES ON THE GULF COAST

One of our best recommendations is a list of the customers we keep! Ellerbee Brothers has now performed contracts for most of the major oil and chemical companies on the Gulf Coast. Repeat work has been done for many of these majors. We feel our success has resulted from the tested formula of experienced and capable personnel working with modern equipment under the personal supervision of men with an average of 20 years experience who take personal pride in each job. We will appreciate an inquiry from you. Write today for the Ellerbee Brothers brochure.

Laying 22" diameter tank farm piping at Mid-Valley Pipe Line Company's Marysville, Mich., station.



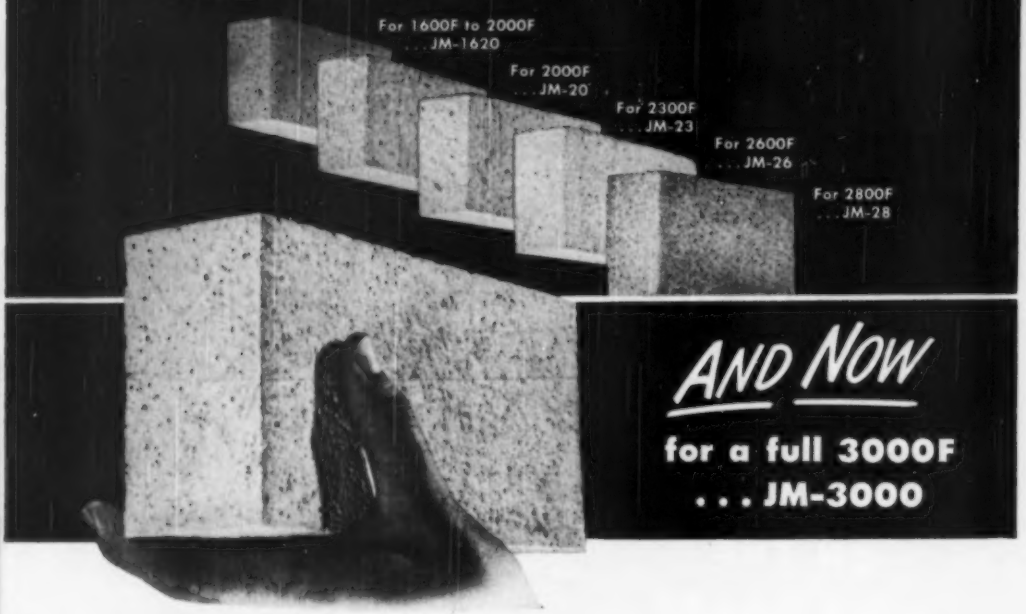
Part of the 103 miscellaneous size welded tanks and overhead piping erected under one contract for a large Gulf Coast Oil company.



This 117' diameter gas type floating roof tank constructed for a major Gulf Coast refining company. Gas mixed shown are in foreground.

ELLERBEE BROTHERS

MEET the family of Johns-Manville Insulating Fire Brick . .



AND NOW for a full 3000F . . . JM-3000

HERE IS AN OUTSTANDING FAMILY of insulating fire brick for back-up or exposed use . . . the only family of its kind . . . that gives you a complete range . . . a ***quick heating*** insulating fire brick for every purpose.

By taking advantage of the quick heating characteristics of these insulating fire brick, you'll benefit through important savings in fuel because of the quicker rise to proper operating temperature in the furnace. This is a result of the low heat storage capacity and low thermal conductivity characteristics of the brick. These factors are especially important where furnaces are being intermittently operated.

The same materials can also be obtained in large size units as Johns-Manville Insulating Fireblok. This product has many advantages over the smaller size fire brick, from both a construction and stability standpoint. They can be quickly applied because they are easy to cut and fit. J-M Insulating Fireblok provide additional heat savings because they reduce the number of joints, and require less mortar for bonding.

Why not have a Johns-Manville insulation expert call to tell you more about ways in which you can save by using these insulations in your furnaces. Write Johns-Manville, Box 290, New York 16, N. Y. for further information.

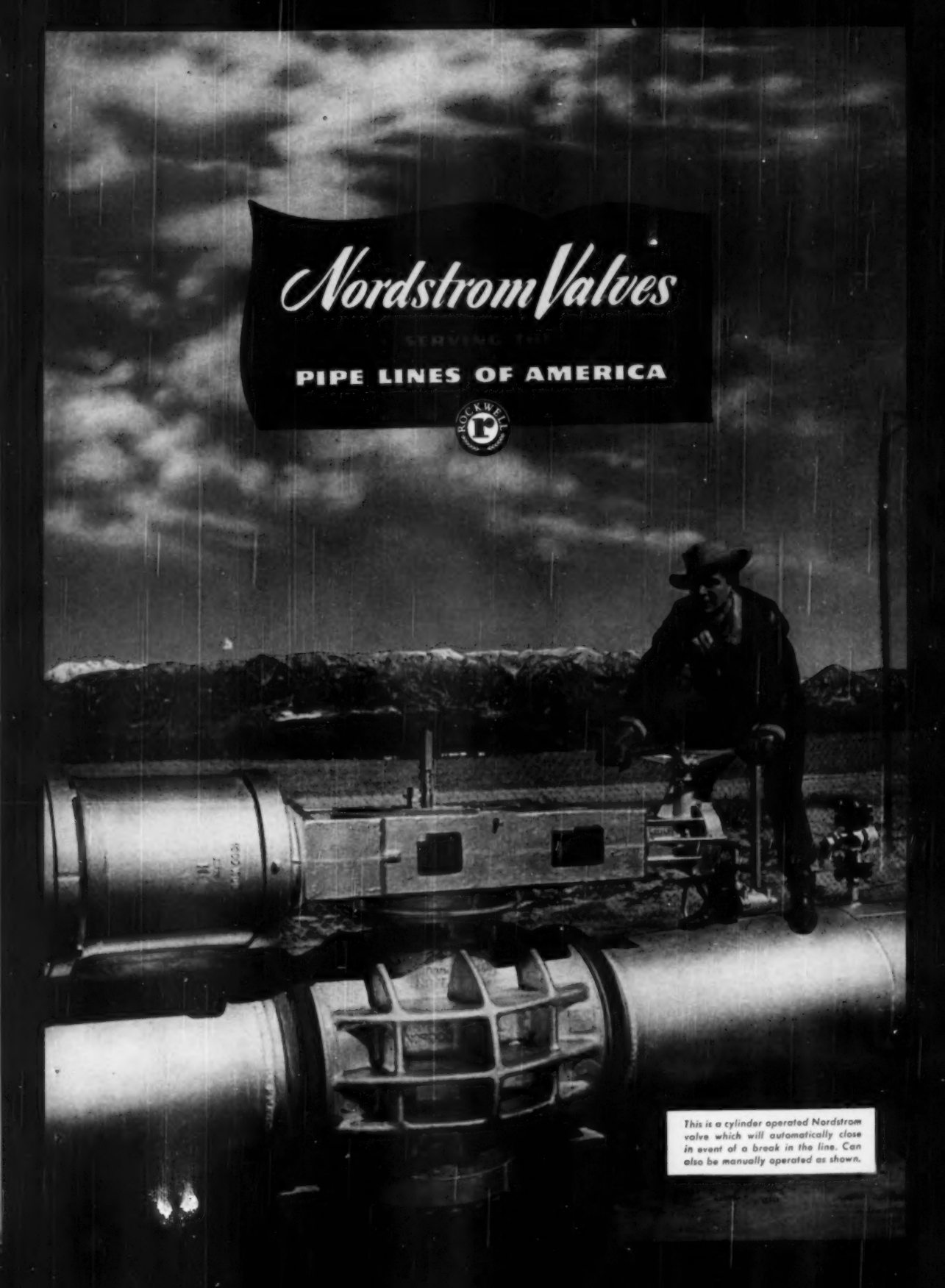
	JM-1620	JM-20	JM-23	JM-26	JM-28	JM-3000
Densities, lb per cu ft	29	35	42	48	58	63-67
Transverse Strengths, psi	60	80	120	125	120	300
Cold Crushing Strengths, psi	70	115	170	190	130	400
Linear Shrinkage,† percent	0.0 at 2000 F	0.0 at 2000 F	0.3 at 2300 F	1.0 at 2600 F	4.0 at 2800 F	0.8 at 3000 F
Reversible Thermal Expansion, percent	0.3—0.6 at 2000 F	0.3—0.6 at 2000 F	0.3—0.6 at 2000 F	0.3—0.6 at 2000 F	0.3—0.6 at 2000 F	0.3—0.6 at 2000 F
Conductivity* at Mean Temperatures						
500 F	0.77	0.97	1.31	1.92	2.00	3.10
1000 F	1.02	1.22	1.91	2.22	2.30	3.20
1500 F	1.37	1.47	2.31	2.52	3.00	3.35
3000 F	—	1.72	2.70	2.82	3.50	3.60
Recommended Service						
Back up	2000 F	2000 F	2300 F	2600 F	2800 F	3000 F
Exposed	1600 F	2000 F	2300 F	2600 F	2800 F	3000 F

† 24-hr simulative service panel test for JM-3000; 24-hr soaking period for other brick.

* Conductivity is expressed in Btu in. per sq ft per F per hour at the designated mean temperatures.

Note: Above tests are in accordance with A.S.T.M. tentative standards.

Johns-Manville First in INSULATIONS


Nordstrom Valves
SERVING THE
PIPE LINES OF AMERICA
ROCKWELL
This is a cylinder operated Nordstrom valve which will automatically close in event of a break in the line. Can also be manually operated as shown.

GAS CONTROL engineered with foresight

MAJOR VALVES IN MAJOR SERVICES

It's the *know how* of designing and making high pressure valves that counts. Given the toughest valve problems of virtually every industry, Nordstrom valve engineers have attained standards far beyond those normally set by industry. As examples: (1) pressures to 15,000-lb test; (2) temperatures to 1000°F; (3) development of brittle-resistant alloys for sub-zero service; (4) Merchrome coating of more than file-hardness to resist corrosion and abrasion; (5) large size designs up to 34-inch; (6) a full line of lubricants; and (7) automatic lubrication by use of Hypermatic lubricant. Nordstrom leads the field.

Nordstrom VALVES

ROCKWELL

Nordstrom Valve Division
ROCKWELL MANUFACTURING CO.
400 N. Lexington Ave., Pittsburgh 8, Pa.
District offices in all principal cities

cooling tower fans?

here's a REAL Recommendation!

where the Hartzite cooling tower fan has been tried it has been specified regularly on following towers by the same user

Except in cases of obvious abuse, *not one* Hartzite plastic fan has ever failed. And thousands of them have been installed.

Where there is a battery of towers, one Hartzite fan goes in, then the other towers are Hartzite equipped as replacement becomes necessary. That's the established pattern.

Practically all the leading cooling tower builders specify this fan—many of them exclusively.

Extremely resistant to shock and vibration damage; practically impervious to weathering and the acids and alkalies found in oil refining; stands up well against abrasion.

Hartzell cooling tower fans of 3' to 10' diameter are aluminum; from 10' to 22', Hartzite plastic. For *dependable*, month-after-month economy and safety, *insist* on Hartzell cooling tower fans. Write —or mail the coupon below—now.

HARTZELL

PROPELLER FAN CO.

DIV. OF CASTLE HILLS CORP.

PIQUA, DEPT. J OHIO

Clip and mail now

Send Hartzell Cooling Tower Bulletin 1502

Name _____

Company _____

Street & No. _____

City & State _____

PROPELLER-TYPE FANS AND BLOWERS—ROOF VENTILATORS—UNIT HEATERS • ENGINEERING OFFICES IN PRINCIPAL CITIES

Stop VALVE SHOPPING!

for BRONZE — IRON — STEEL — CORROSION-RESISTING Valves

POWELL *makes them all*

Fig. 6061 — Class 600-pound Cast Steel Swing Check Valve. Flanged ends and bolted flanged cap.

When you want to buy a new suit, you don't shop for the coat in one place, the vest in another, and the trousers in still another.

But that's just what you do if you get your bronze or iron valves from one source, cast steel valves from another and possibly special design or alloy valves from several others.

No one makes better bronze, iron or steel valves than we do. And, in the field of special design and alloy valves for corrosion-resistance, Powell has always led the way. Today Powell makes the *only* COMPLETE line of these valves available.

In short, Powell makes all kinds of valves* needed in your industry—and makes them better. So stop shopping for valves. Standardize on Powell . . . and centralize responsibility for the efficient operation of the entire flow control system in your plant.

Fig. 6079 — Class 600-pound Cast Steel Gate Valve for Pipe Line Service. Has flanged ends and bolted flanged bonnet. Bevel gear operated. Also available in Classes 150, 300, and 400 pounds.

Fig. 6079 M.O. — Class 600-pound Cast Steel Gate Valve for Pipe Line Service. Has flanged ends and bolted flanged bonnet. Motor operated. Also available in Classes 150, 300, and 400 pounds.

Fig. 1375—200-pound Bronze Gate Valve with screwed ends, inside screw rising stem, union bonnet and renewable, wear-resisting "Powellium" nickel-bronze seat rings and disc.

← Fig. 3033 — Class 300-pound Cast Alloy Steel Angle Valve. Flanged ends, outside screw rising stem, bolted flanged yoke. Streamlined areas through the body assure maximum flow with minimum pressure drop. Built to handle temperatures up to 1400F.

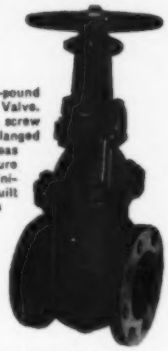


Fig. 1793 — Large 125-pound Iron Body Bronze Mounted Gate Valve. Flanged ends, bolted flanged yoke, outside screw rising stem and tapered solid wedge. Also available in All Iron.

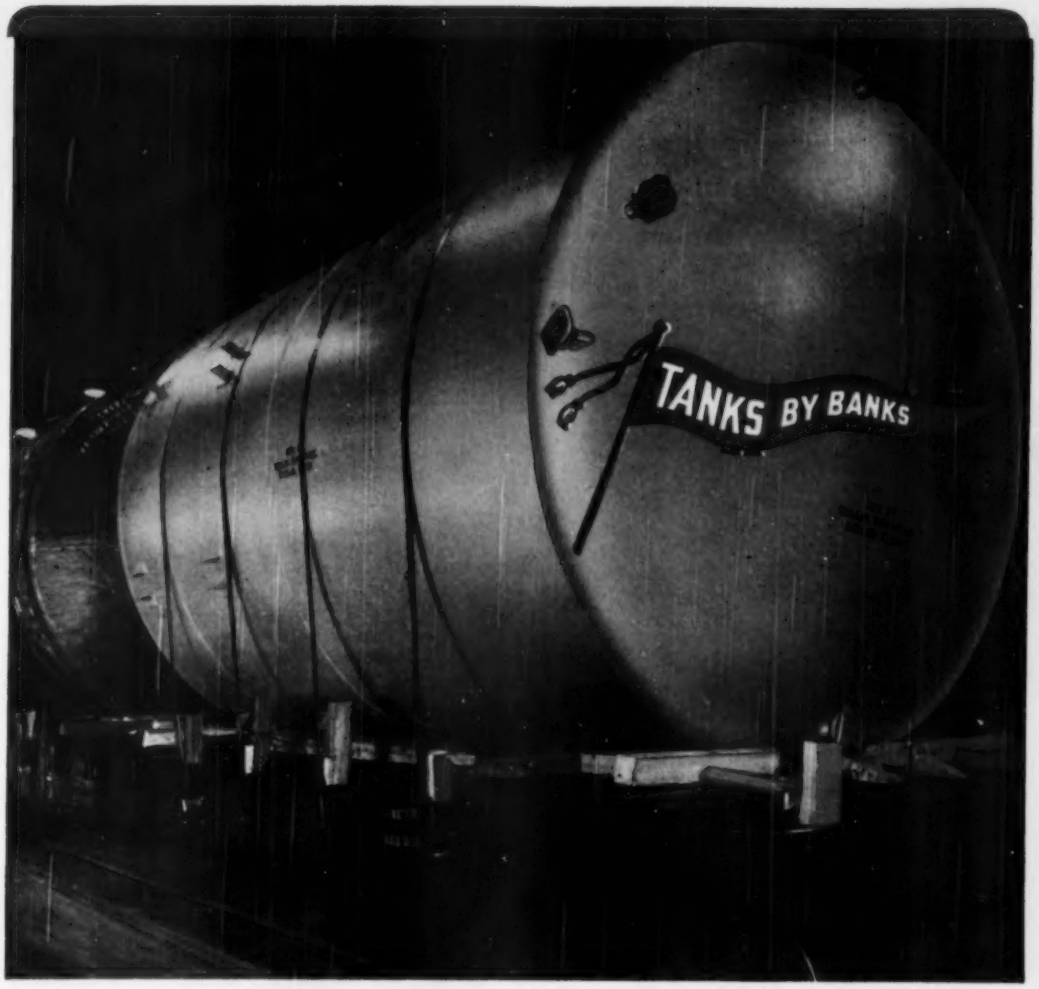
*The Complete Powell Line includes Globe, Angle, "Y", Gate, Check, Non-return, Relief, and Flush Bottom Tank Valves in Bronze, Iron, Steel and a wide range of Corrosion-resistant metals and alloys.

Ask your nearest Distributor—or write direct

The Wm. Powell Co., Cincinnati 22, Ohio

DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

POWELL VALVES



A FAMOUS NAME ON FINE EQUIPMENT

The Red Pennant . . . with its slogan is a symbol of finest quality materials and engineering leadership. It is your guarantee of lasting satisfaction!

Write for complete information

DALLAS TANK COMPANY, INC.

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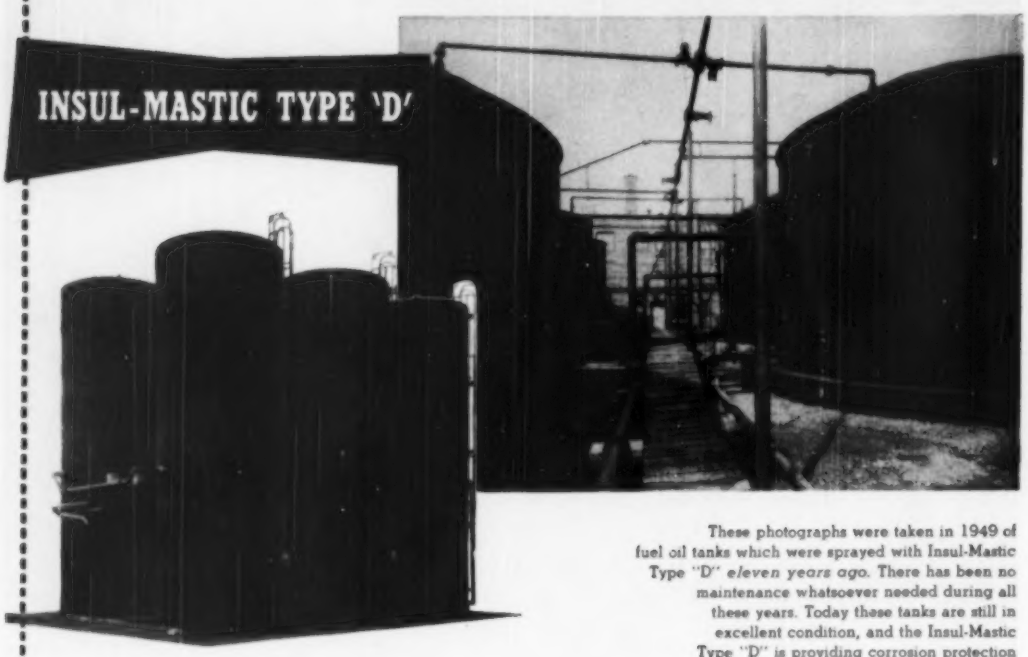
DALLAS, TEXAS

The coating that both insulates and prevents corrosion



These photographs were taken in 1949 of fuel oil tanks which were sprayed with Insul-Mastic Type "D" *eleven years ago*. There has been no maintenance whatsoever needed during all these years. Today these tanks are still in excellent condition, and the Insul-Mastic Type "D" is providing corrosion protection and unimpaired insulating value.

Serves many years without maintenance

INSUL-MASTIC TYPE "D" is the dual purpose coating that not only insulates but also prevents corrosion. It is quickly applied to tanks, ducts, pipes and other metal vessels by spray gun and adheres at any angle without mechanical support.

INSUL-MASTIC TYPE "D" will stop heat flow through metal by 65%, and pays for itself in a short time by fuel saving—such as in the case of oil storage tanks, where heat is used to maintain a free flowing viscosity.

INSUL-MASTIC TYPE "D" also prevents condensation and has proven to be very effective on cold water intake lines in power houses and other places where water absorbent insulations have given trouble.

INSUL-MASTIC TYPE "D" consists of granulated cork thoroughly mixed into a Gilsonite base binder, hence its corrosion preventive and adhesive properties. It is also resistant to most acids and alkalis.

INSUL-MASTIC TYPE "D" is effective between -40° to +300° F. Beyond these extremes, use the Insul-Mastic Vinyl System. Our nearest representative will gladly help you.

Write for further information or see our catalog in Sweet's Process Industries.

Insul-Mastic Corporation
OF AMERICA
OLIVER BUILDING • PITTSBURGH 22, PENNSYLVANIA

Representatives in Principal Cities

...for Efficient HEAT EXCHANGE

Always Specify AEROFIN

Aerofin gas-engine jacket-water cooling installation, La Gloria Corporation, Falfurrias, Texas. Designed to cool 334,200 gallons of water per hour from 155° to 145° using 100° ambient air. Heat transfer 27,850,000 BTU/hr. Engineered and built by Hudson Engineering Co.

Whatever the heat-transfer problem — whatever the medium — whatever materials are required for highest efficiency and lowest maintenance costs, you can always rely on Aerofin.

Unequalled experience and production facilities, plus constant research and materials testing, assure the proper construction and design for greatest efficiency and longest service life. *Ask the Aerofin man.*

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Aerofin is sold only by manufacturers of nationally advertised fan system apparatus. List on request.

NOW! AT NO INCREASE IN COST TO YOU

Makes a good steam trap better

Nearly 650,000 Yarway Impulse Steam Traps have already been installed—proof that they are doing a good job.

Now a *stainless steel* body makes this famous little trap even *better—at no increase in cost.*

Better in *wear*, better in *service*. Users will find Yarways require less maintenance than ever. All parts are wear-resistant, practically wear-proof. There is only one moving part, a small, stainless steel, heat-treated valve. Important, too—Yarway Impulse Traps are *suitable for all pressures up to specified maximum without change of valve or seat.*

Other popular advantages are *small size, light weight, easy installation* and *low cost.* Often it costs *less* to buy a new Yarway trap than to repair an old, ordinary trap.

In performance—ask any user. They all say Yarways are the traps that *get equipment hotter sooner and keep it hot!*

For better steam trap performance, try *new* stainless steel Yarways.

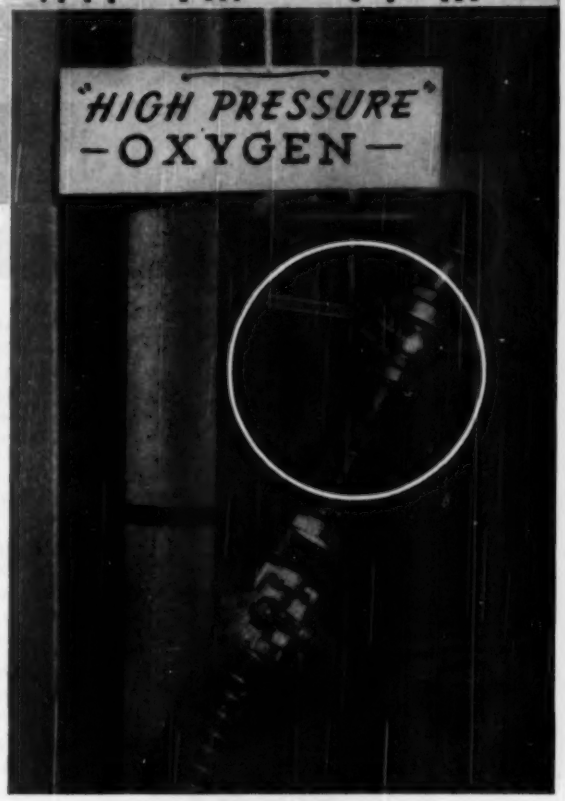
YARWAY IMPULSE STEAM TRAPS ARE SOLD BY OVER 200 DISTRIBUTORS. THERE IS ONE NEAR YOU.

Write for name and address.

YARNALL-WARING COMPANY
128 Mermaid Avenue, Philadelphia 18, Pa.

YARWAY IMPULSE STEAM TRAP

ROCKWOOD BALL VALVES HELP INCREASE STEEL MAKING CAPACITY



No place for leaky valves on this high pressure oxygen line where careful control of the flow of oxygen to the open hearth furnaces is necessary at all times.

The Rockwood Ball Valve was selected by this large steel corporation primarily for its quick turn on and off action and leak proof service. These outstanding features of the Rockwood Valve enables furnace operator to properly control the oxygen which is used for the melting process that helps increase furnace capacity.

The seven features on the right are the secret of Rockwood Ball Valves' dependable service — why you can count on them to stay on the job indefinitely without leaks or maintenance. Industry after industry has found Rockwood Valves reliable — in oil refineries, food, paper, chemical and rubber plants, etc.

You can have Rockwood Valves in bronze in all pipe sizes from ½" to 2" for 300 p.s.i. working pressure.

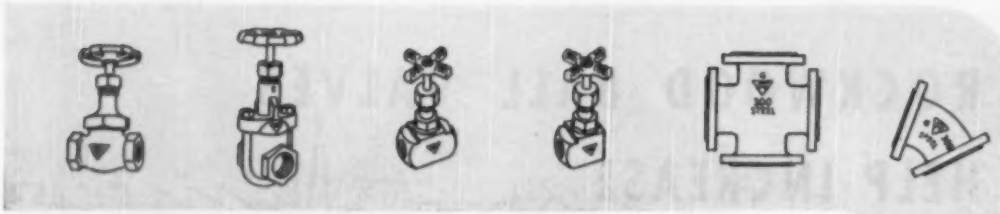
Additional information and uses will be promptly supplied — write for Bulletin V-4.

Distributors in all principal cities.

1. **Full round open area - no turbulence in fluid stream.**
2. **Leak proof after continued use.**
3. **New floating ball - resists pitting, scratching & abrasion.**
4. **No exposed seating surface in open or closed position.**
5. **Easy to open or close under full pressure.**
6. **Installed in any position.**
7. **Quarter turn (90°)opening and closing valve.**

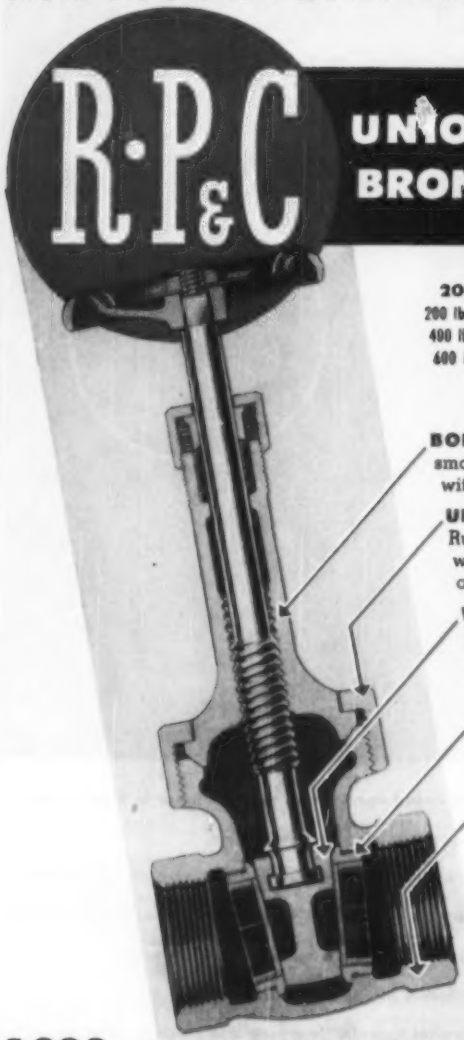
ROCKWOOD SPRINKLER CO

102 HARLOW STREET WORCESTER 5, MASS



ASK YOUR R·P&C DISTRIBUTOR ABOUT

R·P&C UNION BONNET BRONZE GATE VALVES



200 LB. CLASS	300 LB. CLASS
200 lbs. steam at 500°F.	300 lbs. steam at 550°F.
400 lbs. OWG (non-shock)	600 lbs. OWG (non-shock)
600 lbs. Hydrostatic Test	800 lbs. Hydrostatic Test

Integral Bronze Seats
Nickel Bronze Seat Rings

BONNET P & C High Test Bronze with smoothly machined bevel for tight joint with body.

UNION RINGS P & C Valve Bronze. Rugged. Permits repeated disassembly without distortion of body or weakening of threads.

WEDGE Nickelalloy. Reversible. Milled grooves engage guide ribs in body, reducing seat wear. With valve full open, wedge clears line of flow.

SEAT RINGS Nickel alloy (renewable in sizes 1" and larger) or bronze, integral with body.

BODY P & C High Test Bronze. Heavy end hexes. Heavy section and strong threads at union for long service.

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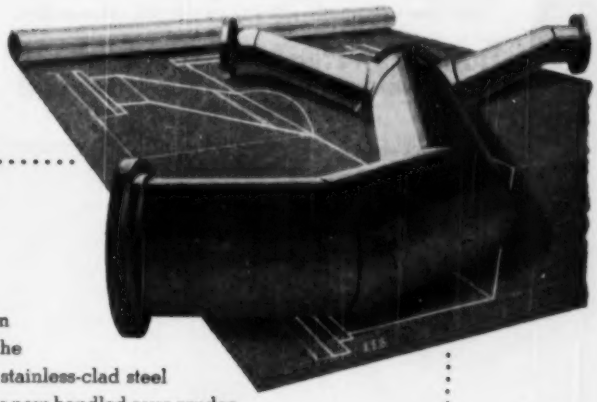
R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

READING-PRATT & CADY VALVES

ONE OF A SERIES DEMONSTRATING APPLIED LUKENOMICS

REFILL FOR ALADDIN'S LAMP

...or how to keep vacuum transfer lines on stream longer



To avoid costly shutdowns in their Persian Gulf refinery, yet keep initial costs low, the Bahrein Petroleum Company installed a stainless-clad steel furnace transfer line. This 151-foot line has now handled sour crudes up to 900°F for over one year . . . without failure. Pipe of other design and materials under these highly corrosive conditions would either have to be replaced within an estimated six months or would be prohibitively expensive. In addition to low initial and operating costs, further economies were also realized in lightweight construction of mitered and welded elbows, which materially reduced shipping costs.

Such strides in equipment design in the last two decades have resulted in increased efficiency . . . lower maintenance and operating costs . . . improved products. Many of these equipment improvements result from the cooperative effort of the designer, engineer, fabricator and materials supplier. We call this *Lukenomics*. Such an approach is at your disposal to help solve today's critical problem—widening the margin between your costs and selling price.

To obtain the advantages of equipment built by fabricators applying the Lukenomics principle, write our Manager of Marketing Service, Lukens Steel Company, 404 Lukens Building, Coatesville, Pennsylvania.

This frog section and the rest of the 151-foot transfer line were fabricated in the United States of Type 405 Lukens Stainless-Clad Steel.

LUKENS

LUKENS STEEL COMPANY

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PERCO DIVISION • CHEMICAL PRODUCTS DEPARTMENT
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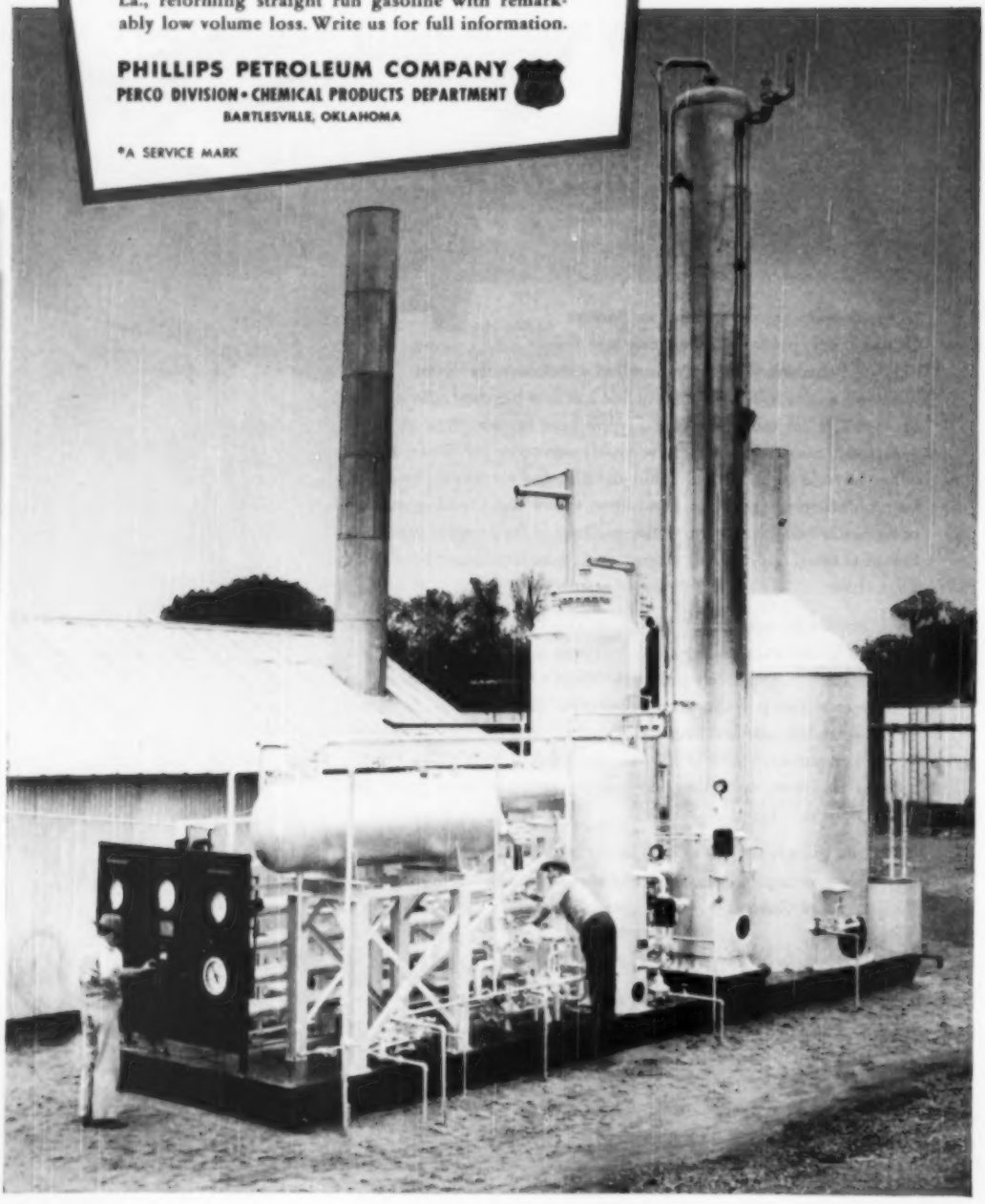
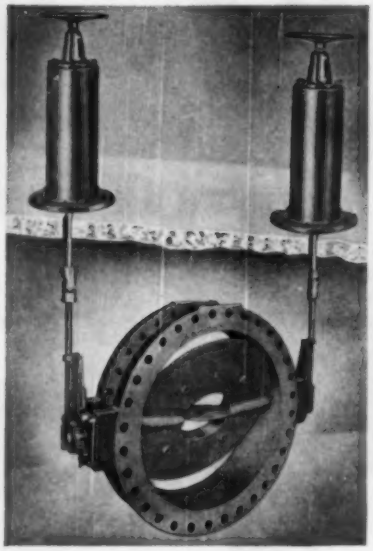


R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



No. 727

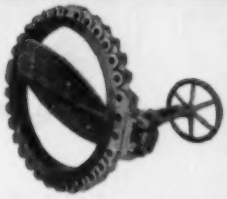
36 inch x 8 inch heavy duty dual valve with 125-pound Am. Std. flanges controls maximum flow with a small pressure drop in large 36-inch valve. By closing large valve, small inner 8-inch valve controls small flow with high pressure drop. Separate handwheel controls for each valve vane patented. Automatic control and drip tight rubber seat available.

7 Advantages of R-S VALVES

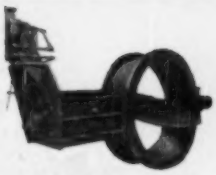
1. Economy in first cost. Minimum number of working parts.
2. Body assemblies correctly engineered mechanically and metallurgically. Equal or exceed A.S.A. standards in every detail.
3. Only a few handwheel turns required for opening or closing.
4. Less inherent pressure loss reduces pumping costs.
5. More control rangeability. Readily adapted to automatic operation.
6. Self-cleaning—no pockets to capture sediment—no objectionable turbulence or wire drawing.
7. Rotary motion of shaft reduces stuffing box problems.

R-S PRODUCTS CORPORATION
Wayne Junction • Philadelphia 44, Pa.

No. 680—Standard heavy duty valve with handwheel control—self-locking worm and gear. Automatic control and rubber seat available with 125-pound flanges. Rubber seated valves are drip tight with water at 100 psig and air bubble tight at 80 psig under temperatures up to plus 275° F. and as low as minus 40° F.

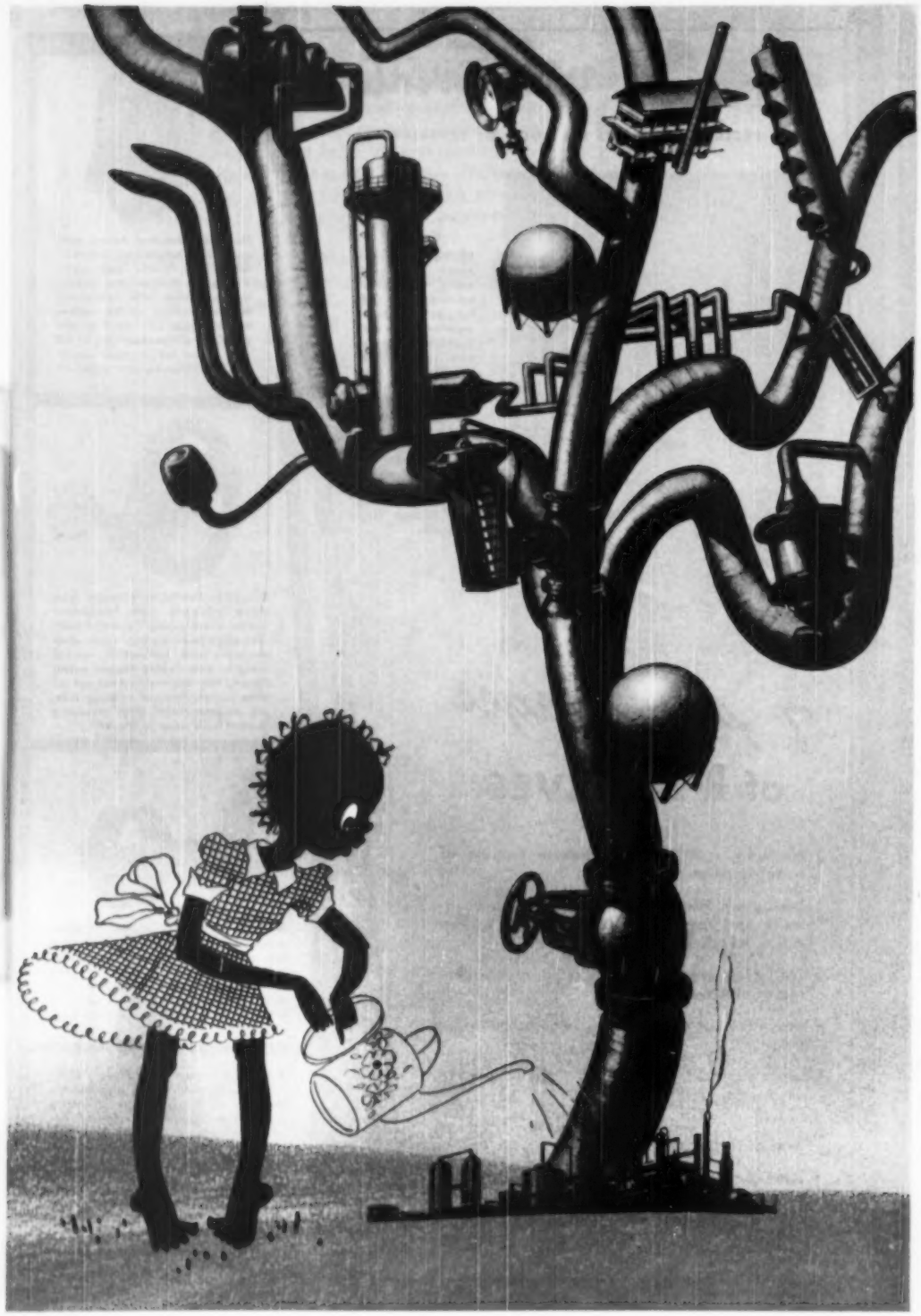


No. 771—Heavy duty wafer type valve equipped with handwheel control—self-locking worm and gear. One-piece body casting. Vane, shaft assembly and handwheel control identical with double flanged valve. Face-to-face dimension does not reduce torque. Flareout on body casting accommodates large mounting bracket base same as No. 680.



No. 734—72 inch 125 pound "H" metal valve for 800° F. Equipped with cooling fins, oil cylinder and positioner utilizing 200 psig operating oil pressure and 0-15 psig instrument air. Positioner cam driven simulating straight-line semi-log control curve or other characteristics if desired.

R-S field representatives maintain experienced engineering and maintenance staffs to study your valve problems, make recommendations and an appraisal of what you may expect from such studies. Specially trained factory representatives are also available for consultation.
Consult with your local R-S representative. Look for the address and phone number listed under "R-S Products, Valves" or write direct.



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A Badger plant is not like Topsy — it doesn't just grow. A Badger built plant is thoroughly planned and planned with imagination and experience.

This planning is apparent in orderly layout of all component parts for easy operation and efficient control. It is apparent in the location of equipment for ready access when maintenance or replacement is required.

Less apparent, but of equal importance, is the attention paid to longer range factors such as the need for future expansion and the effect of reasonably foreseeable technical developments and improvements.

When your plant is designed and constructed by Badger, the value of this planning is quickly demonstrated by operational economy and production quality.

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Process Engineers and Constructors for the Petroleum, Chemical and Petro-Chemical Industries

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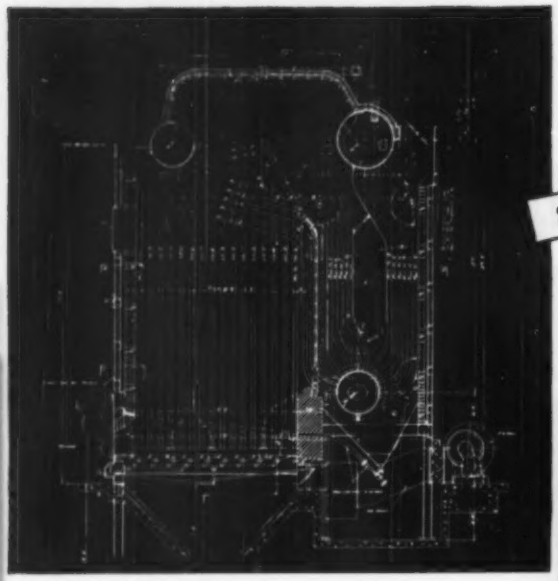
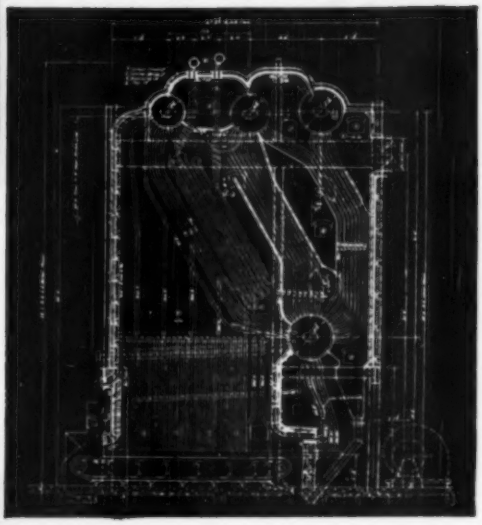


Carry high overloads with high efficiency

SPECIFY Vogt

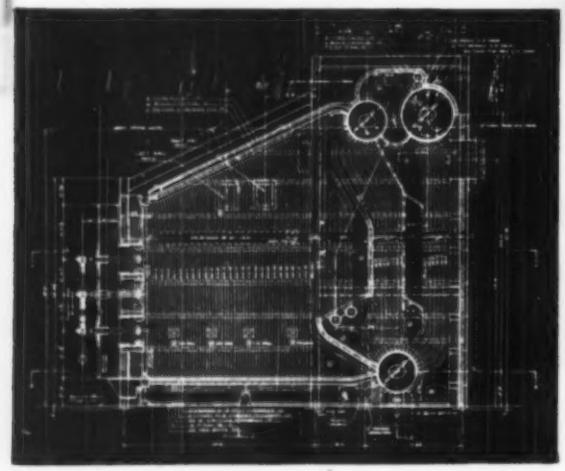
STEAM GENERATING UNITS



CLASS VL Two 27,500 pounds per hour units, installed at Brown-Forman Distillers Corporation, Louisville, Ky. Features large furnace volume in limited space, with high ratio of radiant heating surface.

CLASS LE Mt. Carmel Public Utility, Mt. Carmel, Illinois, is served by this 60,000 pounds per hour unit. Generous steam liberating surfaces and steam space permit wide fluctuations in load.

CLASS VR 70,000 pounds per hour steam generator at Humble Oil and Refining Company, Johnsue, Texas. An efficient, high-duty unit with water cooled furnace, using refinery gas fuel.



Vogt builds a complete line of bent tube steam generators, designed to burn solid, liquid, or gaseous fuels to meet specific operating conditions. Superheaters, air preheaters, economizers, water walls, and soot blowers can be readily incorporated. Bulletins with general information and showing typical installations are available upon request.

HENRY VOGT MACHINE CO.

LOUISVILLE 10, KENTUCKY

BRANCH OFFICES:
NEW YORK, PHILADELPHIA, CLEVELAND
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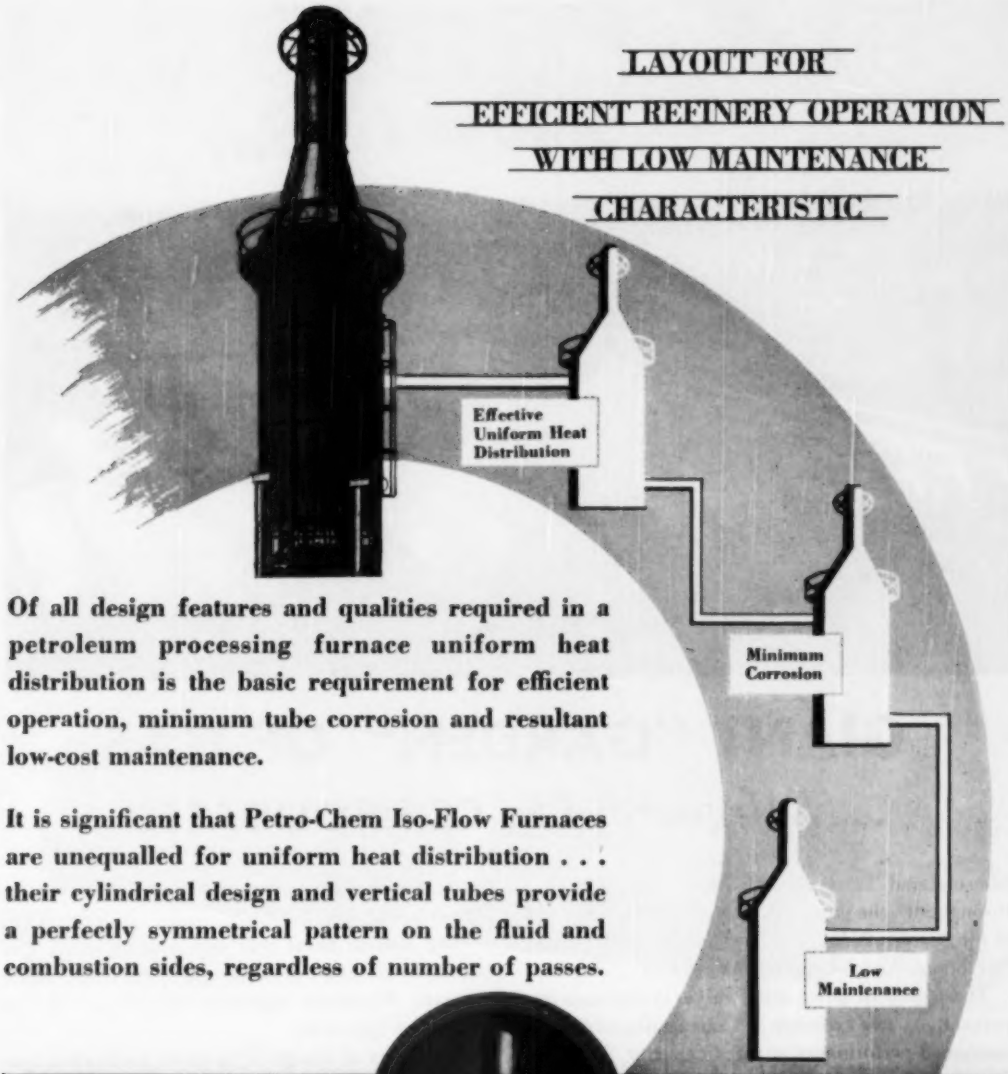
LAYOUT FOR EFFICIENT REFINERY OPERATION WITH LOW MAINTENANCE CHARACTERISTIC



Of all design features and qualities required in a petroleum processing furnace uniform heat distribution is the basic requirement for efficient operation, minimum tube corrosion and resultant low-cost maintenance.

It is significant that Petro-Chem Iso-Flow Furnaces are unequalled for uniform heat distribution . . . their cylindrical design and vertical tubes provide a perfectly symmetrical pattern on the fluid and combustion sides, regardless of number of passes.

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Representatives:
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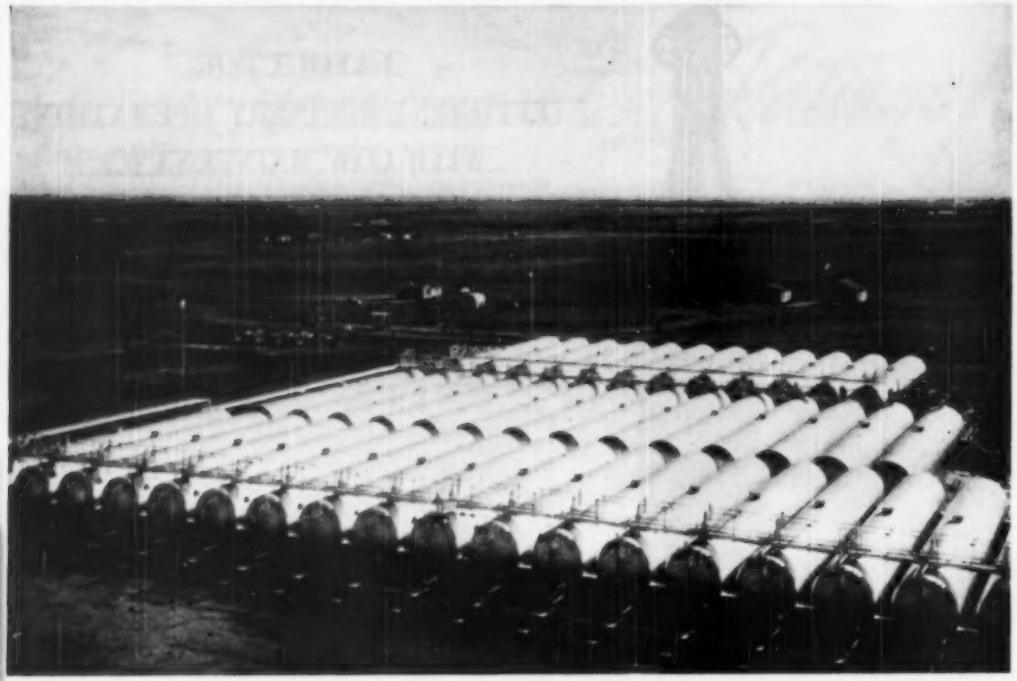
No capacity too large for Petro-Chem Iso-Flow Furnaces . . . throughout the world in the petroleum and allied industries more than 600 Petro-Chem Iso-Flow Furnaces are performing with utmost satisfaction . . . and in many instances operating in excess of their design capacity by more than 50%.



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...*Safeguarded by* CONSOLIDATED

Consolidated Safety Relief Valves are "standard throughout" the vast new storage tank installations of the Warren Petroleum Corporation at Maysville, Oklahoma. And for the best of reasons . . .

These modern safety relief valves incorporate important . . . ***and exclusive*** . . . extra safeguards plus continued performance at rated capacity. The fixed capacity of every Consolidated Safety Relief Valve is ***built in.*** This means these valves do not depend upon the position of multiple adjustable blowdown rings . . . cannot be accidentally altered during maintenance. One adjustment controls blowdown only, without disturbing lift or secondary annular orifice area.

The outside bevel seat and floating guide construction eliminate leakage under discharge piping stresses. Maximum tightness assured for all conditions of operation.

Simplicity of design (25% fewer parts than ordinary valves), reduces maintenance and minimizes standardization problems.

Be ***doubly*** sure . . . of safety for plant and personnel . . . efficiency and economy in operations . . . by specifying only Consolidated Safety Relief Valves.

For complete information, see your local distributor

CONSOLIDATED SAFETY RELIEF VALVES

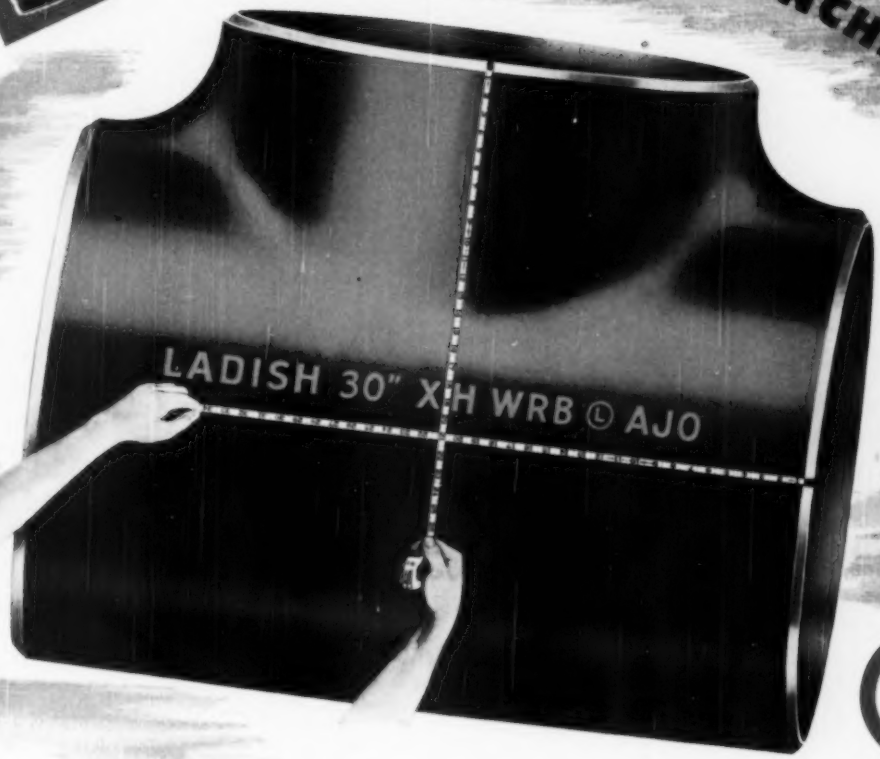
A Product of

MANNING, MAXWELL & MOORE, INC.
TULSA, OKLAHOMA

Makers of 'Consolidated' Safety and Relief Valves, 'American' Industrial and 'Microsen' Electrical Instruments, 'Hancock' Valves, 'Ashcroft' Gauges. Builders of 'Shaw-Box' Cranes, 'Budgit' and 'Load Lifter' Hoists, and other lifting specialties.

full branch tees

½ INCH THROUGH 30 INCHES



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ANOTHER IMPORTANT DEVELOPMENT in the LADISH LINE of

Controlled Quality FITTINGS

To increase safety, ease of installation and welding accessibility . . . Ladish Welding Tees have Full Branch Outlets with identical center-to-end dimension of branch and run as is required for each size *through 30 inches.* Scientific metal distribution . . . pioneered by Ladish . . . adds extra protection by equalizing stress over the entire fitting and assuring maximum strength in every cross section.

THE COMPLETE FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

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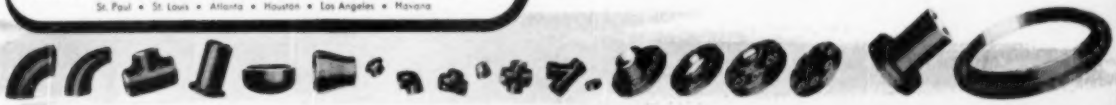

he was on his way to work
. . as usual . . .

Usually he was a careful fellow. But this morning he took a chance. It was one chance too many.

That's the way it is with most accidents . . . whether on the highways, in the home or at work. When you take a chance you take your life in your hands.

Accidents don't care whom they happen to. You are just as likely a victim as the next fellow.

But, fortunately, there is something you can do about it. BE CAREFUL. Don't risk being a statistic on the daily casualty list.

The life you save may be your own.

MR. EMPLOYER:

Because both you and your employees have a stake in avoiding costly accidents The Advertising Council asks your cooperation in posting this vitally important message on your bulletin board.

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A non-profit organization representing all phases of advertising, dedicated to the use of advertising in public service.

230 universities, educational institutions

147 hospitals and other medical groups

1,825 small and large businesses

219 churches, religious organizations

3,500 Standard of California employees

91,000 Americans who invested their savings

Who shares Standard of California Profits?

No college football stadium in the country could seat all the owners of Standard of California.

With 97,000 individual stockholders, it's one of the most widely owned companies in the West . . . and more than 70% of these people are small stockholders with less than 100 shares.

Among the large stockholders, you'll find literally hundreds of companies and organizations which work for you or benefit you every day—hospitals, universities, museums, churches, insurance companies, YMCA groups, research laboratories. And, of course, thousands of our employees are also owners. Standard of California profits, therefore, are divided among a tremendous number of people.

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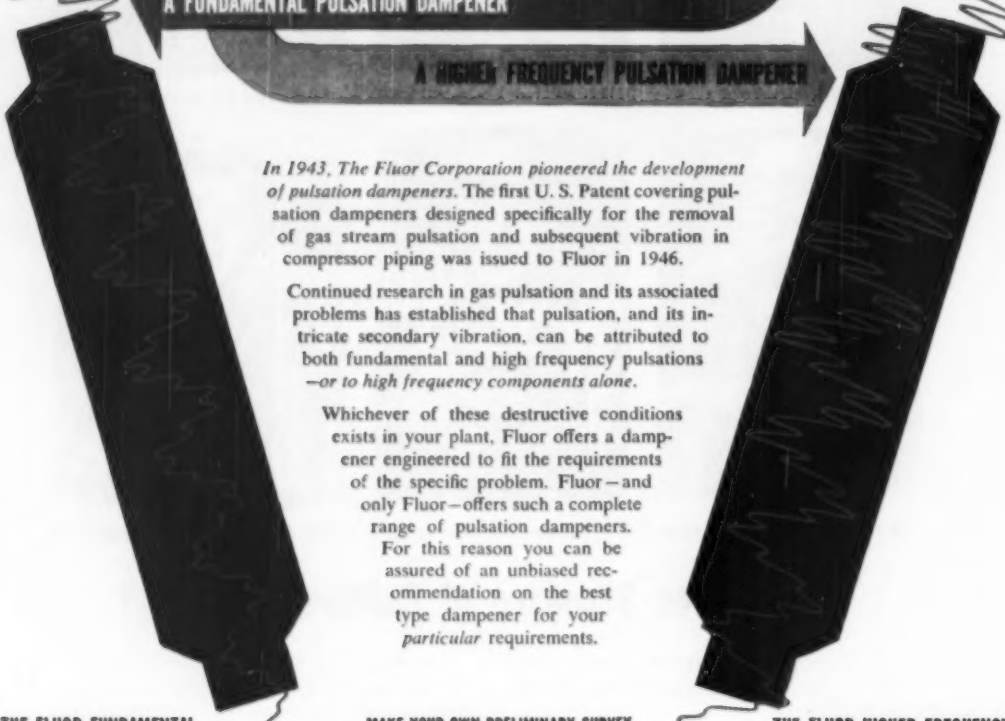
STANDARD OIL COMPANY
OF CALIFORNIA
plans ahead to serve you better

only FLUOR offers this selection

A CHOICE OF TWO PULSATION DAMPENERS TO SOLVE YOUR PARTICULAR PROBLEM!

A FUNDAMENTAL PULSATION DAMPENER

A HIGHER FREQUENCY PULSATION DAMPENER



In 1943, The Fluor Corporation pioneered the development of pulsation dampeners. The first U. S. Patent covering pulsation dampeners designed specifically for the removal of gas stream pulsation and subsequent vibration in compressor piping was issued to Fluor in 1946.

Continued research in gas pulsation and its associated problems has established that pulsation, and its intricate secondary vibration, can be attributed to both fundamental and high frequency pulsations *—or to high frequency components alone.*

Whichever of these destructive conditions exists in your plant, Fluor offers a dampener engineered to fit the requirements of the specific problem. Fluor—and only Fluor—offers such a complete range of pulsation dampeners. For this reason you can be assured of an unbiased recommendation on the best type dampener for your *particular* requirements.

THE FLUOR FUNDAMENTAL PULSATION DAMPENER

This type dampener smooths out all pulsations in the gas stream to the extent of at least 85%. All harmonics originally set up in each pulse cycle are automatically reduced or eliminated. This dampener is the guaranteed answer in plants where structural vibration and metering difficulties are encountered—irrespective of pulsation frequency.

MAKE YOUR OWN PRELIMINARY SURVEY

In many cases you can make your own preliminary survey to determine roughly if your pipe vibration is caused by pulsations. Write The Fluor Corporation, Ltd., Los Angeles 22, California, indicating layout of compressor house piping and operating pressures. A procedure will be mailed to you promptly. No obligation.

THE FLUOR HIGHER FREQUENCY PULSATION DAMPENER

This dampener removes objectionable pulsation frequencies encountered above the fundamental. In many instances, it has been found that metering difficulties and vibration of compressor piping and nearby vessels have been caused by the higher frequency components alone. Available in both manifold and in-line types, this dampener is competitive in cost with muffler or snubber type devices.

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REPRESENTED IN THE STERLING AREAS BY: Head Wrightson Processes Ltd., Teesdale House, Baltic Street, London, E.C.I., England

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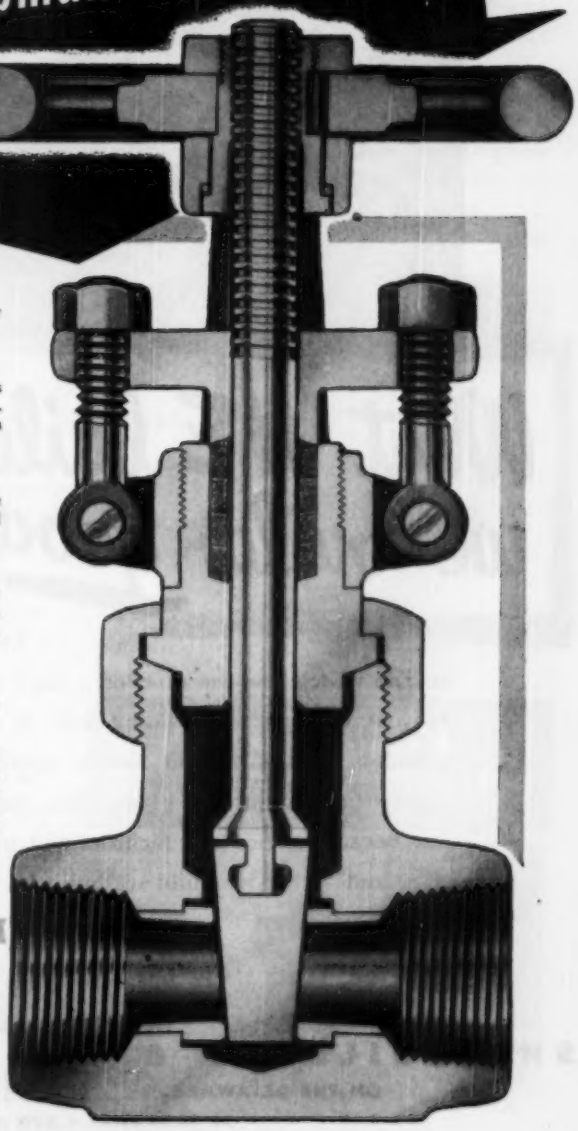
Lower Maintenance Costs
with Chapman List 960



1. *Gaskets!*
Available with either metal to metal or gasketed joint as required.

2. *50% Stronger!*
New design features compensate at points where excessive strain can develop . . . make stem and wedge gate connection 50% stronger than before.

3. *Wear-Resisting Wedge Faces!*
To keep your maintenance cost down the wedge faces are hardened to 800 Brinell by the exclusive Malcomizing process.

4. *Replaceable Seat Rings!*
When necessary, you can replace the seat rings easily . . . fast. Seat rings have wear-resisting and non-galling properties . . . made extra hard for years more service.

5. *Full Pressure Repacking!*
No need for costly interruption of flow to repack.

But check this lower maintenance cost for yourself. Next time you buy specify List 960 in sizes from ¼" to 2". Rising stem with yoke (as illustrated) or rising stem inside screw type. For pressure range 2000 lbs. at 100 deg. F., 380 lbs. at 1000 deg. F. Specify List 990 for higher pressures.

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INDIAN ORCHARD • MASSACHUSETTS

What WE build we build good

This is not a part of a ship or marine vessel, nor the nose of a huge torpedo. It is a section of a 55 foot diameter oil refining unit. It is being built in our plant where a large variety of similar equipment is built each year as regular products of this plant. Note the true shape and the accurate fits. Because of our vast facilities and long experience no job is too large and "what we build we build good."

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SHIPBUILDING & DRY DOCK COMPANY

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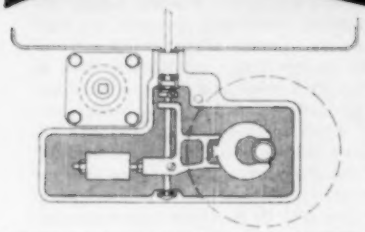
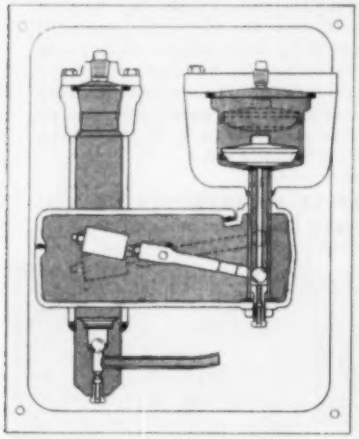
MORE ACCURATE . . . *because it has* MORE POWER *and Less Friction*

The HAYS-PENN MAGNA-CLUTCH MECHANICAL FLOW METER





For HIGHEST ACCURACY

Maximum Power, greatest mercury displacement because of largest float (3.75 in. diam.) and longest float travel (1.5 inches).

Minimum Friction, independent of working pressure because of elimination of pressure-tight bearing, internal knee bearing and shaft end-thrust bearing.

Highest ratio of power to friction.

Precise calibration check at 50 percent of differential available at extra cost.

For LOWEST MAINTENANCE

Manometer accessible without disconnecting piping.

Only one internal moving part (the float).

No bearings to service.

Mercury volume not critical.

Manometer level not critical.

Mercury easily drained.

Positive mercury check valves.

For COMPLETE SAFETY

No leakage possible of inflammable, explosive, or toxic fluids because of no pressure-tight bearings.

For UTMOST FLEXIBILITY

Field adjustable for any differential range:

35″ tube from 17″ to 35″ water
100″ tube from 50″ to 100″ water
200″ tube from 100″ to 200″ water
400″ tube from 200″ to 400″ water
750″ tube from 400″ to 750″ water
1500 or 2500 PSI working pressure

For SPECIAL FEATURES

Any meter may be furnished with any or all of the following features:
Dual (wide range) recording pen.
Simple, accurate integrator.
Temperature and /or pressure pens.

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The HAYS CORPORATION
COMBUSTION & INDUSTRIAL INSTRUMENTS & CONTROLS
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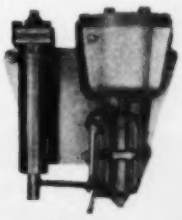
HAYS-PENN *Electric* **FLOW METERS**

1000 P. S. I.



2500 P. S. I.

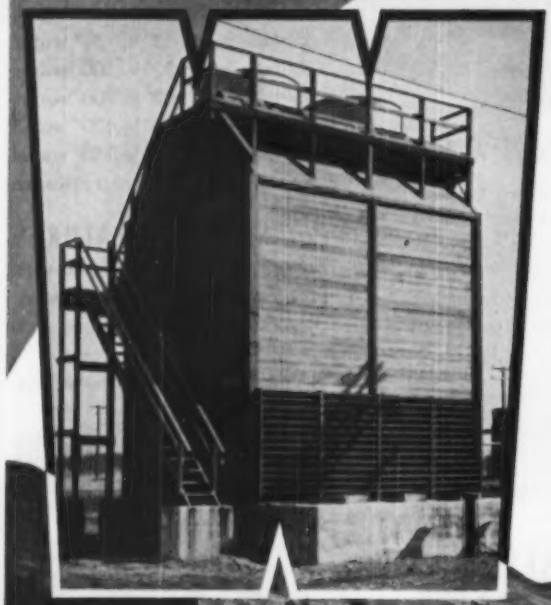
AREA METER 2″ and 4″

LOW PRESSURE

SEND FOR BULLETIN 49-915

WATER'S TOO SCARCE and COSTLY to WASTE

Save it with a C. H. W. Cooling Tower



Look how much this source of water has dried up! And this is no exception, either. More and more plants are feeling the "pinch" in water supply. Industrial expansion, plus higher domestic use, has overtaxed supply in many areas. Good surface water sources are low and, in areas where there is plenty, the quality is poor and costly to make usable. Although sufficient underground water deposits exist,* it will be several years before they can be tapped. All this means that you'll have to get the most out of what you have, or face production cuts or even a shutdown. But there is something you can do—use a C. H. W. cooling tower for operations requiring cooled water, thus permitting use of the same water over and over again. And you'll find that a C. H. W. cooling tower will not only save water and its cost, but also that cooling performance is guaranteed. For any operation requiring cooled water—chemical, processing, petroleum, air conditioning, etc.—check on a C. H. W. cooling tower first. Write for literature.

*According to Government surveys

C. H. WHEELER MANUFACTURING CO.
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STEAM JET AIR EJECTORS
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PERFORMANCE *Often* Guaranteed . . .
PRICE *Never* Padded . . .
On Steel Plate Construction

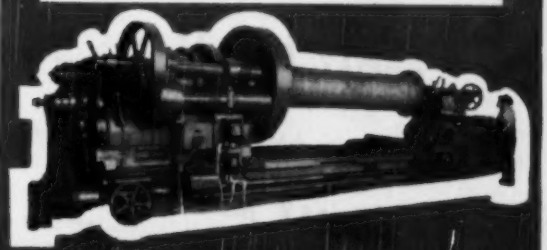
Many Posey installations are actually made with a guarantee that equipment performance will measure up to fixed requirements. Yet often these same installations are fabricated at price *savings* for users.

To eliminate needless costs, Posey's engineers draw upon "case history" files dating back to 1910. Production is supervised by top-flight executives with the authority to cut through red tape . . . by-pass routine. Above all — Posey has the *plant capacity* needed for smooth scheduling of production . . . the modern equipment required by today's construction demands.

A recently published 12-page bulletin tells in picture form, the story of Posey Iron Works' facilities and products. A study of it may show you ways to lower your steel plate construction costs. Write today for your free copy — without obligation.

Posey's 16 ft. Lathe

16' length x 94" diameter lathe gives Posey Iron Works an edge on big jobs requiring lathework. This equipment stands in the South Plant's special erection shop.



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Special Order By Telephone

ONE AMMONIUM NITRATE HEAT EXCHANGER 100% STAINLESS STEEL (ASI TYPE 347)

WESTERN does it in 13 BIG STEPS in 3 DAYS

FRIDAY, March 10

4:00 PM—Phillips Chemical Company, Bartlesville, places rush order by phone.

5:00 PM—ASI type 347 stainless steel ordered by phone from Metal Goods Corporation, St. Louis warehouse.

8:00 PM—Unit put on drafting board; rough draft finished and blueprinted by 11 p.m.

SATURDAY, March 11

8:00 AM—Draft personally carried to Bartlesville for approval.

12:00 NOON —Steel delivered to Frisco in St. Louis by Metal Goods.

3:00 PM—Finished drawing completed in Tulsa.

SUNDAY, March 12

8:00 AM—Materials received in Tulsa via Railway Express.

9:00 AM—Begin machining phase.

4:00 PM—Finish machining all parts — 7 hours.

MONDAY, March 13

7:00 AM—Welding operations begin.

8:00 AM—Assembly work begins.

12:00 NOON —Assembly completed; unit tested hydrostatically and pneumatically.

3:00 PM—Finished Stainless Steel Exchanger shipped to Phillips Chemical, Etter, Texas.

APPROVAL FROM BARTLESVILLE

MATERIAL FROM ST. LOUIS

FABRICATION IN TULSA

DELIVERY TO ETTER, TEXAS

Making final check of specifications before shipment from Western shops

The same technical skilled attention to detail and streamlined production facilities which satisfactorily produced this rush-order on chemical process equipment is applied to all Western Heat Transfer equipment, whether in the chemical, petroleum or pipeline industries.

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HEAT EXCHANGERS

Manufactured by

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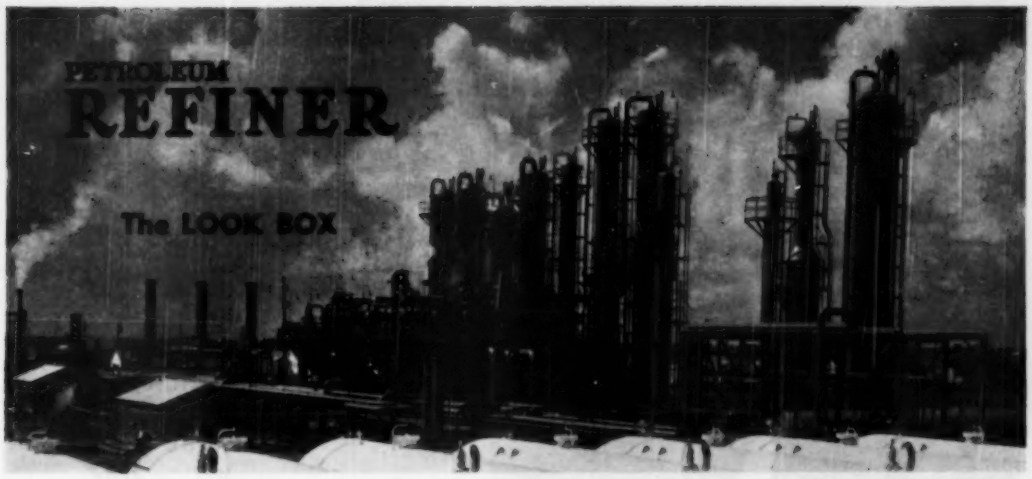


COMPETITION, which has grown like a snowball, is proof that the petroleum industry is anything but a monopoly.

This is the observation of Dr. Robert E. Wilson, chairman of the board, Standard Oil Company (Indiana) who took the occasion of a recent appearance before the National Petroleum Association to emphasize a few facts that too often are being overlooked by critics of the industry.

Snowballing Competition

Documenting his statements, Dr. Wilson pointed out that competition in the Mid-West has cut Standard Oil Company (Indiana) to less than 20 percent of the business in its marketing area, compared with 85 or more percent in 1902. Even so, he added, the company has grown tremendously because of the amazing expansion of the market for petroleum products, and because of the extension of Standard's activities in production and transportation.

"As we of the old Standard Company look back on the 'licking' our competitors have given us, we have no complaint and no criticism," Dr. Wilson commented. "It's a free country. 'Our' territory (Standard of Indiana markets in 15 North Central States—not including Ohio) has no fence around it. In view of the results it might better be termed 'your happy hunting ground.' "We are definitely determined that the long decline in percentage shall not continue if we can reasonably prevent it. But we begrudge no competitor any part of the position he has won or can win fairly in 'our' territory.

"We expect him to try to win more, and we intend to try just as strongly to hold our own. You may have noted that we have done a fair job on that in recent years. 'Our own' in this instance is now slightly less than a fifth of the market where we operate as Standard Oil.

"With all the cry about monopoly where there is none, I hate even to think what would happen if we still had 75 percent, or even 40 percent of the business!"

Standard of Indiana became independent in 1911 as a result of the Supreme Court dissolution of the old Standard Oil organization, Dr. Wilson said. It has earned hundreds of millions of dollars, he said, "for hundreds of thousands of stockholders in its 60 years, and, of course, paid far larger sums to the tens of thousands of workers who have found their livelihood in its service."

"Most of the dollars earned have been plowed back into building a greater economy and enriching human lives in the most amazing half century of progress that the world has ever known," Dr. Wilson pointed out. "Loss of relative position in an industry is outweighed by what has been accomplished.

"In total assets our consolidated company is today about twice as large as it was at the end of 1940, and product sales of the parent company are nearly 60 percent larger than they were then. That would sound like terrific growth in most industries—but it is a little less than the growth of the oil business generally over that period. Standard's competitors have increased from 161 in 1913 to 18,511 in 1931.

"It is difficult to provide comparative figures as of today . . . ," he said. "We have as of the end of 1949 a total of 13,793 operative bulk plants and service stations. We have no up-to-date statistics on competitors. The 1939 census showed a total of 14,891 bulk plants in our territory, owned by 11,963 proprietors, and 78,566 filling stations owned by 75,778 proprietors.

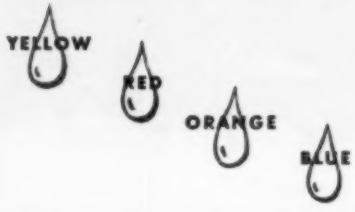
"The figures prove conclusively that there has been no lack of opportunity for competitors to get into the oil business in Standard of Indiana territory, to grow rapidly, and to beat down year after

Top-of-Page Photo—McCarthy Chemical Company's Gasoline Plant No. 2, Winnie, Texas, is processing 85,000,000 cubic feet daily of natural gas. Products from the plant include propane, butane, 200 endpoint gasoline for catalytic reforming, naphtha, and kerosine. The new plant is operated in parallel with the No. 1 gasoline completed in 1945, which has the same through-put capacity.

COLOR-IDENTIFY YOUR GASOLINE...

from the complete line of Du Pont Gasoline Dyes

Recording spectrophotometer tells the complete story of a color—its strength, shade and brightness—in writing. It is used to standardize Du Pont Gasoline Dyes, assuring the refiner of uniform tinctorial properties.



Du Pont Gasoline Dyes have been developed to meet the demands of the Petroleum Industry for dependably uniform colors, and are today accepted as standard.

Possessing high tinctorial strength and good solubility, the four Du Pont Gasoline Dyes may be used independently, or mixed, to obtain virtually any shade or color desired.

Du Pont District Laboratories, conveniently located throughout the country, will be glad to make recommendations as to the mixture and quantity of each dye needed to arrive at the color you desire. They will also work with your laboratory on other additive recommendations. Write or call your nearest Du Pont District Office. Ask for samples.

APPROXIMATE SOLUBILITY OF DU PONT GASOLINE DYES
at 60° F.—Grams/Gal.

	Oil Yellow N	Oil Orange	Oil Red	Oil Blue A*
Straight Run Gasoline	27	24	12	8
Aviation Gasoline	24	25	6	7
Thermal-Cracked Gasoline	42	44	13	13
Catalytic-Cracked Gasoline	72	66	23	12
Benzene	832	242	114	300

*Du Pont Oil Blue A is the new, high tinctorial strength blue gasoline dye, 35% stronger than the previous Du Pont Oil Blue and several times more soluble. Meets requirements of Specification MIL-F-5572 and may be used in aviation gasolines intended for military use.

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year the percentage of business enjoyed by the leading marketer."

Asking, "Who can believe that there is or has been for many decades any lack of competition between oil companies?" Dr. Wilson went on to say, "I wish some of our politicians had to operate a service station or a bulk plant in the Middle West and learn what competition really is."

"In 1902," he said, "we did fully 85 percent of the total oil business in our territory. Today we do less than 20. Then there were only a few dozen jobbers in our area handling competitive goods. Today there are thousands.

"Many companies that existed then exist today either under the same name or as part of successor companies. Many competitors have risen in their day, made their fortunes, and sold out to companies that have become much larger than our company was then.

"In these days your problem is no longer to beat the great 'octopus.' It is rather, to retain the reins of your business free from seizure by 'big government.' This is a problem all business units face—large and small.

"To win the struggle we must help the sovereign people of this land to realize that competition between many free and independent units is the only sound protection of their real interests . . . That fact, I think, stands out crystal clear."

By-Passing Congress

FEDERAL bureaus and departments are seeking to obtain indirectly powers that have been denied by the Congress, according to Donald C. O'Hara, staff attorney of the National Petroleum Association. Speaking before the 47th semi-annual meeting of the association, he cited instances of efforts by the Department of Labor, the Federal Power Commission, and the Federal Trade Commission to increase their powers without complete Congressional review.

He warned industry that "much as Congress is maligned, our chances of getting fair treatment are better when all sides of a question are open to debate on Capitol Hill than when action is taken quietly by a bureau to extend its power."

Although Congress exempted the producing and gathering of natural gas from regulation when it passed the Natural Gas Act in 1938, the Federal Power Commission recently sought to extend its control over independent producers, O'Hara pointed out.

"Congress twice reasserted its intention to exempt such activities in the Moore-Rizley Bill of the 80th Congress and the recent Kerr-Thomas Bill," he added. "It indirectly rebuked such attempts to extend bureaucratic authority when the Senate refused to confirm the President's reappointment of Leland Olds as a Commissioner."

The petroleum refining industry may be confronted with a minimum wage rate well in excess of $1.00, despite Congressional approval of a statutory minimum wage of 75 cents and rejection of the $1.00 minimum proposed by the Labor Department, O'Hara warned. He explained that the Labor Department is taking advantage of the Secretary's power under the Walsh-Healey Act to determine rates in industries that do substantial amounts of business with Government, although that Act was superseded for practical purposes by the Fair Labor Standard Act of 1938.

O'Hara predicted that the depletion allowance for oil production income allowed by the Internal Revenue Act will be sustained despite its being "under the most vicious attack ever made on it with the president characterizing it as a 'loophole' in the tax laws. Nevertheless, every time it has been subjected to study by Congress it has been sustained and we are confident that it will be sustained again."

The President's transfer of the Employment Security Administration from the Federal Security Agency to the Labor Department was characterized by O'Hara as "a conspicuous example of avoiding complete Congressional review of increases in bureaucratic powers." He noted that Congress twice rejected this transfer, and that it intended only to grant power for administrative changes to increase efficiency in the Reorganization Act under which the President accomplished the transfer.

Two similar proposals, he warned, are now pending: 1) to strip the Wage-Hour Administrator of his semi-independent status and to transfer his power to the Secretary of Labor, and 2) to abolish the office of General Counsel for the National Labor Relations Board, making the Board "once again prosecutor, judge, and jury."

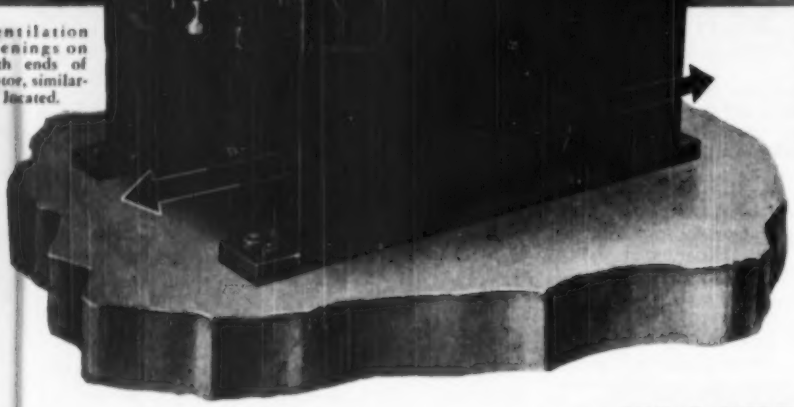
Proposals by the Federal Trade Commission to increase the penalties for violation of FTC orders from a flat $5000 per violation to $5000 for each day a violation continues, were repeatedly rejected by Congress, O'Hara said. Commission attorneys, he said, then succeeded in having it included as a "sleeper" provision in the recent bill to repeal the oleomargarine tax.

THE factor of mergers in the growth of larger businesses has been greatly distorted in public discussion. As an example, 60 percent of Du Pont sales in 1949 resulted from products that did not exist or were in their commercial infancy 20 years ago and none of the 60 percent came from mergers. The proportion of Du Pont assets today represented by acquisitions of other companies is 12 percent.

Every day is election day in American industry in the sense that the American consumer, by his purchases, votes daily as to which companies shall succeed, grow large and stay large, or vice versa.

—HAROLD BRAYMAN, Director Public Relations, E. I. du Pont de Nemours and Company.

Ventilation openings on both ends of motor, similarly located.



This new motor is the result of several years of experimental observation and testing of various types of splash-proof motors actually installed outdoors under severe conditions, such as salt fogs, hurricanes, sand storms, etc.

A revolutionary *new* ELLIOTT STEEL *outdoor* SPLASH-PROOF MOTOR

- Protected from all directions against wind driven rain.
- Wind driven foreign matter blows straight through inlets and outlets without entering motor.
- Inlets and outlets baffled internally—air taken into motor at low velocity.
- Screens or filters may be added to inlets.
- Sealed split ring-oiled sleeve bearings or anti-friction bearings.
- Stator coils with mica wrapper on slot portion for 2300 volt and higher class "A" insulation. Stator coils vacuum—pressure impregnated.
- Stator and coils after winding given one complete dip and bake, and end turns two additional dips and bakes.
- Foundation may be a simple, economical slab. Does not need to be special or have expensive cored openings.
- No objectional air recirculation.
- All steel frame and brackets coated inside and out with rust inhibiting finish.

Built in sizes 150 to 2000 Hp. 4 to 14 poles.

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Plants at: JEANNETTE, Pa., RIDGWAY, PA.
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Pittsburgh 19 ..... 718 Frick Building
San Francisco 4 ..... 1504 Russ Building
St. Louis 3 ..... 1221 Locust Street
Seattle 1 ..... 1101 Vance Building
Tulsa 3 ..... 616 McBirney Building
Washington 1, D. C. ..... 1001 Washington Gas Light Building
Wilmington 7 ..... Industrial Trust Building

THE perils of our present political and economic situation have been set forth by many in eloquent fashion. Eisenhower and Stassen are preaching a rousing doctrine of individual, personal independence, self-respect and responsibility as a substitute for the subservience and regimentation we must accept as the price of a breakfast-in-bed economy. Dr. Vannevar Bush sounds a solemn warning that we have more to fear from the decadence of our own personal strength of character than from any violence from outside our borders.

My first premise: The trend of affairs in these United States represents a creeping revolution leading to "planned economy" and members of the business community cannot ignore its significance. Are these scare words? Maybe they are, but I do not think so. We deplore the sweeping tide of popular delusion, that an all-embracing government alone can bring ever more abundant life to all with less work and lesser responsibility, and at someone's else expense. We know our abundance is not the result of accident, nor is it automatically assured. In the light of world history and present national example, it is a veritable miracle in the release of human ability and productive energy.

Yet, under the temptation of alluring plans for making material prosperity automatically available to all, irrespective of merit, productive contribution or responsibility, we are rushing toward steps that would destroy the very source of prosperity. We, the American people, are truly facing a decision between retaining our faith in individual self-reliance, opportunity and responsibility, or following the political mirage down what Dr. Nourse so aptly calls "the slippery road to misery."

Making Influence Felt

The danger exists, and we all know it, which leads us to premise No. 2—doing something about it, making our influence felt—as American citizens. Not the other fellow—us. Every one can recall innumerable occasions—daily in occurrence—when we have indulged in mutual indignation parties—consoling each other and just reinforcing each other's fears and frustrations. Well, maybe it does relieve us to blow off steam, but how much better to put that steam to work! Unless we try to make some impression on others, it does little good to increase our own blood pressure.

There are millions of people whose viewpoint can be changed, people who hold the balance of power, in spite of the multitude that have perhaps hopelessly lost faith in themselves and in America. We can find fertile ground if we search, and we can sow the seed of returning confidence. We sell faith in our manufactured goods or in the services we have to offer enthusiastically and with fire in our eye—why not our faith in our American heritage? If we fail to sell that, the day is plainly coming when there is no selling in America—there'll only be telling. It's up to us, and the time is now.

Trouble in Fevered Heads

Premise No. 3 is important—at the bottom of this problem, it is not material things, but men's thoughts and feelings that really count. We have multiplied our abundance, distributed it more widely, heaped bounty on top of bounty, with no apparent effect on the general level of satisfaction other than to increase the clamor for more bounty. The real trouble does not lie in empty stomachs, but in fevered heads. Let us make no mistake—the battle is for men's minds. That is the kind of a battle for which we must choose our weapons and shape our plans.

To this point, we have dealt with generalities, just to build a background. From here on out, an effort will be made to offer practical ways in which all of us can draw on our experience, our daily contacts and our personal resources to make our influence effective.

First of all, we can best focus our efforts through the normal everyday channels of business and private life that are open to every one of us. Pronouncements from on high and to the world at large perhaps have some useful place, but mainly fall on deaf ears. The message that travels over established lines of communication, that comes from a known and respected source is the message that finds its mark and carries conviction. Put yourself on the receiving end—whom would you be inclined to believe—a business associate, a conscientious and considerate employer, a respected friend, or some stranger whose message may happen to reach you over the radio or on the printed page?

In our corporate responsibilities we have our employes, our customers, our stockholders, our plant communities—channels ready made for us. The "precinct" system is what the public relations fraternity calls it. Industrial corporations are becoming increasingly aware of these opportunities and taking carefully planned steps to make sound, effective use of them.

However, the opportunities do not end with our business responsibilities. Every one of us has myriad personal contacts—friends, trade acquaintances, domestic employes, club or church associations—why not talk about something besides the weather. Above all, we learn by doing—let's get started, and the more we do, the easier and more effective it becomes.

Facts First on List

Next, the ammunition we use on this job. At the top of the list place *facts*—not idle talk and wild haymakers, but supportable facts, straight, hard punches right on the button.

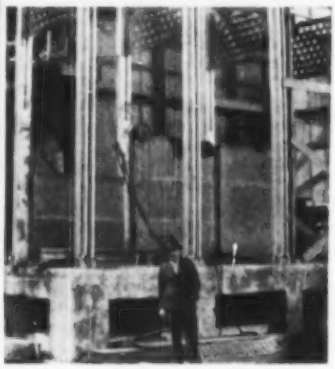
We are proposing to deal with a situation where *misinformation* is the rule, rather than the exception. The facts of economic life are direly understood by the public in general, and this educational vacuum has been seized upon by the perverted prophets and designing schemers of Utopian unreality as their golden opportunity to spread the gospel of confusion and prejudice. While the responsible business community has largely maintained an aloof dignity, perhaps in the naive belief that the material accomplishments of business would be its own defense, a campaign of deliberate smear and misinformation against business and businessmen has made unbelievable progress.

Taking Up the Cudgels

Resignation to this situation on the part of business at last is being discarded,

Increase the Efficiency and Performance of OIL HEATERS and OIL STILLS with A. P. Green Lightweight Castable Refractories

Refractories are applied to the steel panels at the job-site. Only simple formwork is required in lining the panels with castables.



Erection is simplified by installation of pre-fabricated panels.

Our 40th Year Serving the World's Industries

This type of [illegible] represents only one of the numerous [illegible] castable refractories in the petroleum refinery. For the application of lightweight castables in your plant, consult the Engineering Department of the A. P. Green Fire Brick Company.

A. P. Green Castable Refractories applied to Panel Casing Construction in new or old oil heaters and stills, offers you these 6 advantages:

1. Use of lightweight castable refractory materials developed for high operating temperatures.
2. Securely anchored lining—gives long, trouble-free service.
3. Increases the performance and efficiency of the furnace. With fewer joints air infiltration is reduced to a minimum.
4. Simplified construction—reduces erection time.
5. Lowers maintenance costs. Any tube section may be repaired by removing a series of the panels without disturbing the balance of the furnace arrangement.
6. Lower foundation costs due to the use of lightweight materials.

The A. P. Green Fire Brick Company Engineering Department will assist you with further information on the application of these materials to new units or the conversion of existing furnaces. Call your local A. P. Green distributor—he's listed in the yellow pages of your telephone directory—or write . . .

APG-59

A. P. Green REFRACTORY PRODUCTS

A. P. GREEN FIRE BRICK COMPANY
Mexico, Missouri, U. S. A.
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DO YOU KNOW THESE

facts about treating?

FACT 1 Mercaptan *removal* is today's answer to deodorization problems.

FACT 2 Modernizing with the *Tannin Solutizer Process* for mercaptan removal yields "new refinery" economies in treating and blending your finished leaded gasoline.

FACT 3 *Conversion and operating costs* are extremely low.

FACT 4 The Tannin Solutizer Process is not *corrosive*.

FACT 5 The high efficiency of the Tannin Solutizer Process has been conclusively demonstrated during more than *five years* of commercial refinery operation.

FACT 6 The Tannin Solutizer Process does not affect the *stability* of the gasoline treated.

FACT 7 Complete Tannin Solutizer *process engineering* service is available—during the planning of your unit, at start-up, and thereafter if required.

We will welcome the opportunity to work with you on your specific problem. The Tannin Solutizer Process is licensed under the patent rights of Socony-Vacuum Oil Company and Shell Development Company.

SHELL DEVELOPMENT COMPANY

50 West 50th Street, New York 20, New York

SHELL

and vigorous cudgels in the defense of business are being taken up with increasing frequency and, it is hoped, with increasing effectiveness. The first step toward effectiveness seems to me to let in the light of truth—to challenge the outrageous allegations that have been accepted by a credulous public, not with more wild words, but with facts, patiently and consistently demonstrated, and nailed down by solid, thoroughly prepared argument.

Here are a few actual situations—

If you were to ask the average man how much profit a large and successful business makes, what do you think he would guess? Well, polls have been taken on that subject, and the answers are astounding. The majority of guesses run from 25 to 50 percent profit and more. If a man thinks companies make profits like that, why wouldn't he think it was too much? But would he think it was too much if he knew the truth? The pollsters have asked that question, too. The man in the street figures 10 percent profit would be fair. And 10 percent profit is double the profit of the average American company. Du Pont can claim to be a quite successful company, and its return on the investment used in its business in 1948, the most recent year for which figures are available, was 9.3 percent. The United States Department of Commerce official statistics reveal that for the first nine months of 1949 the profits of all American corporations were only 4.7 cents of each sales dollar. That's something you can sell in this battle for men's minds.

Here's another. The idea is being sold by unsupported assertions that the big companies are taking over the small ones so fast that pretty soon there won't be anything but a few big businesses. The government figures that a business employing 1000, or more, people is a big business and reports that there are in the United States 975 companies in that category. But that is only 975 out of four million. Four million companies in the United States, and only one in over four thousand is what the government calls "big business."

Parallel Growth

As a matter of fact—and this is the heart of the matter—they've got further to go now than they ever had before. They aren't even gaining in the race. The little fellows have been growing at a terrific rate . . . the number of businesses in the United States was only a million and a half in 1900. The truth is that both small and big business have been growing at much the same rate, because they are partners and each other's best customers.

The rich, they tell us, are getting richer, and the poor are getting poorer. That isn't the story the government figures tell. The facts are these: families with incomes of under $5000 a year now receive almost 90 percent (89.8) of total wages and salaries earned in the United States, and the over-$5000 families, the 10 percent left. After taxes, the take-home share of the over-$5000 bracket is only 5½ percent of the national income. Moreover, the under-$5000 group receives 69.4 percent of dividends and interest paid, and collects 83 percent of the rents. That hardly looks as though the upper-level incomes account for most of the money.

While we comfort ourselves in the belief that facts are our first dependence for combatting the indiscriminate smear charges against business, this implies something on our own part. We must remember that facts are neither automatically available nor automatically effective. An army depends as much on getting its ammunition to where it is needed as in shooting it, and so must we in this battle.

The Logistics of Fact

There is a wealth of material available, and, more important, valuable agencies are helping to select it, condense it, and make it more readily usable by us. For instance, the "National Fact Book" is one of many excellent aids supplied by the National Association of Manufacturers. It supplies up-to-date statistics in condensed form on public finance, banking, national income, prices, wages and earnings, employment, production, construction, and other pertinent headings—and is available to both members and to interested non-members. Foundations and associations are also contributing useful analyses and statistic, and are working for us in a way that merits our support.

There is ample ammunition at hand but we must take our time and effort to organize it to our purpose and to train ourselves to use it effectively. Perhaps, there are enough professional economists, but we can do a better job by at least qualifying as competent amateurs.

There is a practical "don't" which seems to me worth keeping in mind, and that is to avoid a querulous, defensive attitude. We can hardly blame the "Oh, yeah" response from the public toward some of the "For God's sake, they can't do this to us" type of argument which has been used too frequently. From time immemorial worried businessmen have agonizingly proclaimed that such and such a thing could not be done without completely and permanently wrecking business—yet repeatedly that thing has been done, and business goes on at the same old stand. We won't get far by appealing to pity.

In fact, it is only human nature to enjoy seeing the other fellow get a bit of kicking around as long as one thinks it doesn't affect himself. Big business in the hot seat—so what—hasn't there always been trust-busting? And the big boys are still flourishing.

The Real Loser

What is important is not that business is being mistreated and businessmen being pelted with undeserved volleys of rotten eggs, but that the man in the street will be the ultimate loser if the current attack on business should succeed. The liquidation of big business is vociferously demanded and in certain official quarters actively promoted. Who loses when mass production and development of new products, both dependent on the large resources of big business, are the victims of political persecution? Would our man in the street feel so complacent about it all if he had any realization of the threat to his standard of living, to his chance for a better job, and even to the frightening responsibility to make America secure in a profoundly disturbed world?

It comes down to the fable of the goose that laid the golden eggs—but it's no fable now, because it is being acted out right before our eyes. Our job is to convince people that the industrial goose does lay golden eggs—that it can't lay those eggs unless it is kept alive and in health—and that if they kill it or let it be killed, *they* will be just as hungry as we are.

Everybody Wants Security

As another "don't" in a somewhat similar vein, it seems to me that we defenders of business let ourselves be put in the apparent position of generally opposing the desirable objectives of higher living standards, sound security, and greater justice for the average man. Of course we want them, and the human race has always wanted them and always will.

The socialists tell us we can attain those ends if we will only adopt their methods. We might be tempted to be socialists too if we were not sure that socialism wouldn't work. We believe in free enterprise and the free market place, with maximum individual opportunity and responsibility, precisely because we can conceive of no other organization of human society which offers as much hope of progress toward the goal of material and spiritual satisfaction for all.

And yet, in opposing what we feel to be illusory promises of an easy way to attain something that must be earned, not distributed by political favor, we find ourselves maneuvered into the apparent position of opposing the very ends we most desire.

The problem is certainly easier to pose than to answer. It is just another of those exasperating, baffling examples of combatting wishful thinking and artful misrepresentation which confront us in all phases of our work.

A simple, homely illustration of our

These are among the leading petroleum companies with Kellogg designed-and-constructed Propane Deasphalting and Decarbonizing units:
• Anglo-Iranian Oil Company, Ltd.
• British American Oil Co., Ltd.
• Cities Service Refining Corp.
• Cie. Francaise de Raffinage
• Gulf Oil Corporation
• Humble Oil & Refining Co.
• Kendall Refining Company
• Mid-Continent Petroleum Co.
• The Pennzoil Company
• Phillips Petroleum Company
• Pure Oil Company
• Shell Oil Company
• Sinclair Refining Company
• Standard Oil Company (Ohio)
• The Texas Company
• Utah Oil Refining Company

4 out of every 5 barrels of Propane-Deasphalted oil are processed in Kellogg-designed units!

Yes! Kellogg has engineered and built over four-fifths of the world's Propane Decarbonizing and Deasphalting capacity . . . and there's more under construction!

WHEN it became obvious years ago that asphalt-free crudes would not meet the growing demand for lubricating oil stocks, development work was started to obtain quality lube stocks from asphaltic crudes. Eventually this development work grew into the familiar JUIK (Jersey-Union-Indiana-Kellogg) series of propane processes, basic among which was Propane Deasphalting. First utilized successfully as a settling process in horizontally-positioned equipment, Kellogg later developed the present counter-current tower method.

Efficient, non-critical in operation, and extremely flexible over a wide range of feed and product specifications, Kellogg engineers subsequently saw in the basic principles of the process an excellent method for reducing the carbon content of cat cracker feed stock, thus increasing the potential capacity of any cat cracker. Kellogg has designed and sold such units since 1942.

As licensing agent for all such projects, and as the designer and builder of more than four-fifths of the world's capacity, M. W. Kellogg offers unduplicated background to refiners considering addition of such facilities.

PILOT PLANTS PLAYED MAJOR ROLE IN PERFECTING PROPANE DEASPHALTING!

If any refining process owes its acceptance to pilot plant work, most certainly it is Propane Deasphalting. Kellogg's first pilot plant for this process was started back in the early thirties. It was followed by others, including the latest pilot unit pictured here. Operating characteristics and economics were so thoroughly investigated on these pilot plants in hundreds of separate runs that widespread commercial acceptance of the process was achieved practically overnight on the basis of pilot plant data.

IT TAKES ALL SEVEN TO PRODUCE GREATER EARNING POWER . . .

3. SPECIALISTS IN EVERY PHASE
of DESIGN ENGINEERING in true depth. There are, for example, 14,000 square feet of floor space devoted to piping engineering alone . . . eight separate divisions to parallel the eight major phases of refinery engineering: piping, heat transfer, vessel and furnace, equipment, instrumentation, structural, electrical and operation. And behind this array of personnel is an exclusive compilation of data, continually created and collected during more than thirty years of the oil refining industry's greatest growth. From "Equilibrium Constants" to "Design of Piping Systems," both considered authoritative tracts within the industry, to special standardized templates for drawings, the Kellogg organization puts in the hands of its Engineering Division every necessary "tool" to deliver outstanding performance.

1 THE DEVELOPMENT "TOOLS"
—laboratories, pilot plants and recognized specialists to prove and improve processing and equipment ideas.

2 PROCESS ENGINEERING
by three distinct groups of specialists—*sequence* engineers, *unit* engineers and *development* engineers—supported by an extensive reservoir of exclusive data.

4 SPECIALIZED BUYERS
backed by the cumulative buying power of the largest company in the business.

5 COMPLETE FABRICATING FACILITIES
to make schedule deadlines and to develop workable "firsts" in refinery equipment.

6 CONSTRUCTION KNOW-HOW
acquired in completing hundreds of major jobs, plus an ample supply of the proper tools, and the constant development of new money-and-time-saving methods on the construction lot.

7 PRACTICAL OPERATING COUNSEL
on all design and construction, achieved through practical operating men working as an integral part of the company.

. . . AND ONLY KELLOGG HAS ALL SEVEN!

The M. W. Kellogg Company, (a subsidiary of Pullman, Inc.), New York, Jersey City, Los Angeles, Tulsa, Houston, Toronto, London, Paris

predicament is the famous revolving cylinder in the amusement parks at Coney Island, through which you try to walk in an upright position instead of finding yourself unceremoniously on the back of your neck or scrambling on your hands and knees. The inside is smooth and devoid of anything to tell you what is at the moment the bottom, side or top. The secret of keeping one's equilibruim is to look through the barrel to the stationary landscape beyond, where up and down stay put. By this guiding beacon, the proper diagonal course over the surface of the revolving cylinder is maintained with confidence, and we emerge with our dignity intact.

There is just one simple fact—businessmen do want to see our standard of living raised, to see more people have more things. But we want to see those things gained on a sound, enduring basis. We have got to sell that fundamental truth.

Wealth Is Created

Not only that. American business has made these advances possible, because it has provided the mechanism for the creation of wealth beyond anything known in history. Make no mistake about it, our living standards have not improved *only* because we have wanted it that way. They have improved because we have produced the wealth to make them possible. And in that effort, no one has contributed more than American business. If we're not proud of that, why should anyone else be proud of it, or even know of it?

We might now turn to a very critical facet of this undertaking to sell the American enterprise system, and that is the power of example set by business management and by us businessmen personally in the conduct of our affairs. As the old saying has it, "What you *do* speaks so loudly, I cannot hear what you say."

Businessmen are a cross-section of the American people, good and bad. There is unconscionable gouging going on in certain instances. There are unwarranted and unfair profits being made through questionable dealings, just the same as there are unearned wages being paid to lazy people and feather-bedders.

A lot of companies these days have public relations departments. Are they expected to be whitewash departments, to make fancy speeches and pay graceful tribute to civic responsibilities and then have deeds belie the fair words? That can be equally true of small companies, in which the boss is his own public relations man.

Syrup Is No Cure

We are outraged by the soothing syrup that politicians are handing out to the public and sometimes forget our own propensities to dispense soothing syrup. Hardly a day goes by but that the papers tell us of businessmen running to Washington for handouts, while decrying to high heaven against the interference of government in business. When they find the public disinclined to risk their money in uncertain business, they trot to the government for capital. The big and little both come; there is the big businessman seeking millions, and there is the little businessman seeking a few thousand.

We give lip service to competition, and then shrink from the rigors of its honest practice.

It is an unfortunate fact that unwise and downright indefensible performance in too many instances is responsible for the public's lack of faith in business and its managers. We have given the anti-business forces altogether too much basis for their charges of exploitation and lack of conscience and sincerity on the part of business.

What is admittedly bad in part and in local situations has been cleverly blown up to condemn the whole.

The result is that by and large it is not business management, but the politicians and the crusading labor tsars who are popularly looked to as the friend of the average man. A lot of it is pure bunk, but can't afford to fool ourselves.

Example Is Best Defense

What seems to be particularly significant is that this popular distrust of business has never made progress in many local situations against the influence of sound practice and understanding management. Concrete example can overcome the delusion that business is heartless and unmindful of its responsibilities to employes, customers and its neighbors.

Oases of confidence have never ceased to exist. The kind of performance that preserved these oases can create more, and lead the way back to increased respect and understanding from the public.

Who is going to do it? Nobody but the personal managers of business. Not one of us can escape some measure of responsibility—either in business or in personal decisions. We have a message to get across—whether we succeed or fail depends much on the demonstration of our own personal sincerity. It is the personality of the corporations we help to manage and the personality of you and me, individually, that earns acceptance of what we say. We are knocking at men's minds, and the door will not be opened unless we come as honored guests.

In closing we should give some thought to the dangers of fooling ourselves.

The first fact we must look squarely in the eye is that free enterprise is not easy to sell. We may enjoy the happy impression that it doesn't need to be sold, that it sells itself and all Americans love it, but it certainly isn't so. In all human history people have been intrigued with the easy way to material ease and escape from responsibility, and that is the very bait offered by socialism and its handmaidens, the "New Deal" and the "Fair Deal."

Free enterprise depends upon the courage, ingenuity and intestinal fortitude of individual men and women. It presupposes that each of us can stand on his own feet. Competition requires that there be losers as well as winners—and that the loser, if he has the courage and stamina, have an opportunity to try again. That's a challenge, not a tempting invitation to the discouraged or the lazy.

It is because of its competitive nature that our economic system has produced on so enormous a scale, and it cannot continue to produce if we scrap incentive in an effort to provide security for one and all. That kind of security isn't sécurity at all. It is economic quicksand, and we've got to do what we can to make sure that the American people doesn't wander into its sure destruction.

The Struggle Lies Ahead

Also, we should have no illusions that the battle to preserve freedom and opportunity is ever won. It is a struggle toward an ideal goal and goes on ceaselessly. The reward is in the doing, the satisfaction that we may help to gain a few rungs in that long ladder that leads to a better-ordered world. Through the centuries, man's history has been one of painful progress and disastrous reverses. Nations before us have served well their people and the world, then gone soft and succumbed to their internal poisons. We can lose, and lose disastrously, unless we have the faith and the will to struggle ahead.

We are in a critical position now. The bewildering rush of scientific discovery, the amazing strides in communitions which have crowded the whole world's confusions on our doorstep, the aftermath of two disastrous world wars—these things and many others have led to a ferment in men's minds and emotions that makes these days the cross-roads of history.

And at such a time we could not do better than to remember the words of a great newspaper man, the late Raymond Clapper, who said: "Never under-estimate the intelligence of the American people, but never over-estimate their information."

There is our job—get the facts across to the American people—honestly presented, and sold with sincerity and conviction—and we need not fear their judgment. We *can* do something about it, by undertaking, every one of us individually, to make sure that the judgment of the American people does not fail because of lack of understanding about its staunchest wheel-horses—business and industry.

It was 1912 — and dances like the "Turkey Trot", "Bunny Hug" and "Fox Trot" caught the public's fancy — when we introduced "Flexitallic", the *original* Spiral-Wound Gasket, and opened to Industry new fields of opportunity in the confining of fluids at high pressures and temperatures.

"WHAT IS THE RIGHT GASKET FOR THIS JOB?"

Every Flexitallic Spiral-Wound Gasket is engineered from the ground up for operation at specified temperatures and specified pressures—and to meet particular conditions of thermal and physical shock, corrosion, vibration, or unusual joint stress.

The basic Flexitallic principle—the spiral winding of V-crimped spring-like metal plies alternating with plies of filler—lends itself to almost unlimited variation in material and structure to meet the varying demands of use.

The physical and chemical properties of the metal, the type of filler, the relationship of filler to metal in the winding—all these are variables in the hands of the Flexitallic engineer who is designing a Flexitallic Gasket for a specific use.

Using the most precise instruments for the determination of yield values, resilience and gasket density, the Flexitallic engineer builds each Flexitallic gasket to an exact standard of performance.

Many Flexitallic Gaskets—originally designed as "specials" for oil refineries, chemical industries, power plants, shipyards, ship operating companies—are now "standard" gaskets in the Flexitallic line.

If safe sealing is of serious concern to you, give us these facts on your gasketing requirements: (1) Fluid to be confined; (2) Type of flange and dimensions; (3) Operating pressures and temperatures; (4) Bolting data.

In return we will send you a genuine Flexitallic Spiral-Wound Gasket. Test it severely—in your laboratory or on the job. The results will show you why most industries in the high-pressure, high-temperature field are standardized on Flexitallic Gaskets.

FLEXITALLIC GASKET COMPANY
Eighth and Bailey Streets, Camden 2, N. J., U.S.A.

The name "Flexitallic" is the registered trade mark identifying the *original* (patented) Spiral-Wound Gasket. Now—for your protection and ours—this trade mark FLEXITALLIC is stamped into the outer ply of every *genuine* Flexitallic Gasket. Your guarantee of quality.

Flexitallic®
SPIRAL-WOUND GASKETS

Refining and Other PLANT CONSTRUCTION

(Tabulation Starts on Next Page)

"NEW HIGH"—termed "the tallest refinery unit in the world", this (right) quadruple-reactor Houdriflow unit at the Toledo, Ohio, refinery of Sun Oil Company reaches 308 feet skyward. It is described as the only catalytic cracking unit of its kind in operation and is part of a $22.5 million expansion program. Completed early last month, this work has almost doubled the size of Sun's Toledo plant, which now has an ultimate crude capacity of 70,000 barrels. The new catalytic-cracking plant has a capacity of 30,000 barrels of charging stock. Other major installations added at Toledo include a 30,000-barrel distillation unit, a vacuum distillation unit, and new gas compression, distillation and purification plant. The catalytic polymerization unit has also been doubled in size. Catalytic Construction Company was the prime contractor for the Toledo expansion program.

Mathieson, Tennessee Gas Venture $27 Million Merger

Some 2000 acres of land near Brandenburg, Ky., southwest of Louisville on the Ohio River, have been purchased by the newly formed Mathieson Hydrocarbon Chemical Corporation, a $27 million venture of Mathieson Chemical Corporation and Tennessee Gas Transmission Company. Approximately $17 million worth of chemical units which will be constructed on the site, are scheduled for completion at the end of 1951. The organization will also build a $6 million plant for the production of raw material components at another location.

Officers of Mathieson Hydrocarbon are president, Thomas S. Nichols, president of Mathieson Chemical Corporation; executive vice president, John C. Leppart, executive vice president MCC; Russell Hopkinson, administrative vice president; vice president, operations, Carl F. Prutton, vice president-director of operations MCC; and treasurer-secretary, S. deJ. Osborne, vice president-treasurer, MCC.

Tennessee Gas Plans New Hydrocarbon Plant

A low-temperature separation process will be utilized in the new extraction and recovery plant to be erected adjacent to Tennessee Gas Transmission Company's natural gas pipe line system near Greensburg, Ky. The $12 million stripping plant will process in excess of 600 million cubic feet of gas daily from which will be obtained some 400,000 or more gallons daily of ethane, propane, butane and natural gasoline.

Initial construction is expected within the next two months and completion for the summer of 1951.

The liquid hydrocarbon stream will be sold to the newly-formed Mathieson Hydrocarbon Chemical Corporation and transported through a new eight-inch pipe line to be laid by Mathieson from the Greensburg location to its new chemical plant which is planned for construction near Brandenburg, Ky., on the Ohio River.

Kendall Platforming Unit Is Contracted by UOP

A 1500-barrel-per-day platforming unit, the same size as the Old Dutch Refining Company's unit at Muskegon, Mich., will be built at Bradford, Pa., for Kendall Refining Company. Contract covering the design, engineering and erection of the unit has been awarded to Universal Oil Products Company with completion expected late in 1950.

Pan-Am Southern Contracts Foster Wheeler

Foster Wheeler Corporation has been contracted to build a second fluid cat cracking and vapor recovery unit at the El Dorado, Ark., refinery of Pan-Am Southern Corporation. Expected completion is within the next 12 months. The facilities which will process 9000 barrels a day of gas oil to high octane gasoline and furnace, will increase the refinery crude capacity about 20 percent or to 30,000 barrels a day and permit production of 16,500 barrels daily of motor gasoline.

The coking unit started last September is approximately 35 percent erected with September completion scheduled.

Foster Wheeler to Build McColl-Frontenac Unit

Foster Wheeler Limited, St. Catharines, Ontario, has begun contracted work in the design, procurement of materials, and field erection of a crude processing and cat cracking unit for the new refinery of McColl-Frontenac Oil Company, Ltd. at Edmonton, Alta. When completed in 1951, approximately 5500 barrels a day will be processed from the Leduc and Redwater fields.

Contract for certain aspects of the $10 million project will be let to a number of Canadian companies.

Lubrizol to Construct New Houston Lube Plant

Additives for crankcase lubricants will be produced at The Lubrizol Corporation's new plant to be constructed in Houston "as soon as possible," according to Kent H. Smith, president. The company has acquired 30 acres of property for the new facilities.

Lubrizol's research and engineering labs and general offices will continue at the Cleveland headquarters where a program of enlarging and adding new equipment to the main manufacturing plant at Cleveland will be started soon.

Kellogg to Construct Pennzoil's Deresin Unit

Designed to charge 1370 barrels of Pennsylvania reduced crude each day, The Pennzoil Company's new propane-deresining and resin-fractionating unit at the present lube oil plant at Rouseville, Pa., will be constructed by The M. W. Kellogg Company. The unit is scheduled for completion by the end of this year.

Products will include light-colored, low carbon-residue deresined oil, which will be further processed for the manufacture of high quality lubricating oils, and three resin fractions of exceptionally high viscosity which are expected to be marketed as specialty products.

Several new design features not previously used in plants of this type promise desirable flexibility in controlling product quantity and quality.

CONDOR Votes Increase In Building Financing

A voted increase in CONDOR capital to 3000 million lire will be used partly to finance construction work progressing on the Rho refinery located on the northwesterly outskirts of Milan, Italy. Annual crude capacity is a rated 12 million barrels. Other portions of the expenditure will finance work on a seaport installation at Genoa and a pipeline for the transport of crude from there to Rho.

Atlantic Refining Dallas Building Is Completed

Newly opened southwest headquarters of The Atlantic Refining Company, a 10-story building in Dallas, incorporates 274 individual offices.

Of welded steel construction throughout, the $3 million building is completely air-conditioned. The outside facing is of Indiana limestone. Interior features include ceilings of acoustical tile and special flooring laid with lightweight pumice floor aggregate.

New Venezuelan Plant Scheduled for Operation

New facilities of Venezuelan Gulf Refining Company's 30,000-barrel-per-day refinery at Puerto La Cruz, which will produce principally gasoline, furnace oil, diesel fuel and heavy fuel oil for world markets, was scheduled for on-stream operations April 25. Ownership is two-thirds by Gulf Oil Corporation and one-third by The Texas Company through operation subsidiaries.

Socony-Vacuum Company's Suggestion System Pays Off

In slightly less than two years of operations, the suggestion system of Socony-Vacuum Oil Company, Inc., has awarded $46,691 to 1701 employes. The dollar savings to the company from these suggestions are estimated to have amounted to $161,032. A total of 9365 suggestions were received.

Of the suggestions submitted in 1949, 22.1 percent were accepted and the average individual award was $26.

REFINERY and Other PLANT CONSTRUCTION

The tabulation appearing below, and on four additional pages, is a regular PETROLEUM REFINER feature which, it has been shown, fills a definite need in the processing industry.

To the end that the tabulation appears correct and complete each month, readers are asked to 1) send in "boxscore" data (as called for by the column headings) on projects not listed; 2) furnish details which are missing in any item in the current tabulation and 3) report from time to time on the progress of these projects.

Such cooperation, of tremendous aid in keeping the tabulation continuously up to date, will be much appreciated.

Address Editor, Petroleum Refiner, Box 2608, Houston 1, Texas.

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
Calif. Refg. Co.	Barber, N. J.	Crd. Cat. Crk., Reformer, Alkylation	25,000 bbls. 10,000 bbls. 5,000 bbls.		Under Constr.	Jan., 1951	Houdry U.O.P. Kellogg	Houdry, Braun Braun Kellogg	Braun Braun Kellogg
		Crude Units Boiler Plants	50,000 bbls. 300,000 lbs./hr.					Braun Braun	Braun Braun
*Calif. Refg. Co.	Barber, N.J.	3 Gaso. Trtng., Lead Sulfide Sweetening Plt., Reagent Plt.			Contracted			Cat. Constr.	Cat. Constr.
E. I. Dupont	Parkersburg, W. Va.	Tetrafluoroethylene Resin Plant			Under Constr.	Summer, 1950			
Esso Standard Oil Co.	Richmond, Va.	Essotane Bottling Plt.	3,500 gals.	$70,000	Under Constr.	May, 1950		Staff	Howard-Mitchell
Esso Standard Oil	Bayonne, N.J.	Steam Boilers	400,000 lbs. hr		Under Constr.	May, 1950		S.O.D., Day & Zimmerman	S.O.D. & Zimmerman
Freeport Sulphur Co.	Westville, N.J.	Sulfur Recovery	40 tons		Under Constr.	1950			Girdler
Socony-Vacuum Oil Co.	Paulsboro, N.J.	Propane Deasph.	5,950 bbls.		Under Constr.	2nd Qtr., 1950	Juik Texaco	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	MEK Dewaxing	3,300 bbls.		Completed			Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	Light Oil Trtng.	28,000 bbls.		Completed			Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	Mod. Comp. Plg. Dept.	5,000 bbls.		Completed			Staff	Staff
Socony-Vacuum	Buffalo, N.Y.	Houdry to TCC	15,000 bbls.			1950			
Socony-Vacuum	Brooklyn, N.Y.	Houdry to TCC	15,000 bbls.			1950			
L. Sonneborn Sons	Petrolia, Pa.	Antipollution, Acid		$450,000	Under Constr.	2nd Qtr., 1950		Chemico, Knowles	Keen & Wise, Chemico
Standard Oil Co. (California)	Mobile, Ala.	Ref. Conversion, Enlargement			Completed				
United Refining Co.	Warren, Pa.	Lab. Steam Gen.	60,000 lbs. hr.			4th Qtr., 1950			Union Iron Wks.
MID-CONTINENT									
Ashland Oil & Refg. Co.	Canton, Ohio	Change to Poly, Light Ends Plts.	1125 bbls.	$40,000	Completed		U.O.P.	Staff	Cat. Constr.
Cities Service, Del.	Cicero, Ill.	Compound Plt.	1,200 bbls.	$4 million	Contracted	July, 1950			Sollitt
Consolidated Gas Utilities Corp.	Cement, Okla.	Compr. Sta.	40,000 mcf		Under Constr.	2nd Qtr., 1950		Dresser	Dresser U.O.P., Brown & Lite
Deep Rock Oil Corp.	Cushing, Okla.	Cat. Cracker	5,000 bbls.		Under Constr.	Spring, 1950		U.O.P.	J. & L. Constr.
The Derby Oil Co.	Wichita, Kans.	Cat. Crk. Change			Planning				
Dewese Oil Co.	Weston, Ohio	Lube Filtering	250 bbls.	$15,000	Under Constr.	Spring, 1950		Staff	Staff
Indiana Farm Bureau Cooperative Assn.	Mt. Vernon, Ind.	Fluid Cat. Cr.	4,500 bbls.		Under Constr.	1951		U.O.P.	Staff
Indiana Farm Bureau	Mt. Vernon, Ind.	Gas Concen.	3,500 bbls.		Under Constr.	1951			U.O.P.
Indiana Farm Bureau	Mt. Vernon, Ind.	Vacuum Unit	300 bbls.		Under Constr.	1951			U.O.P.
Magnolia Pet.	Chitwood, Okla.	Compr. Plt.	24,750 mcf		Under Constr.	May, 1950		Staff, Constr. Service	Delta Constr. Service
Midland Co-Op. Wholesale	McPherson, Kans.	Expansion	122,000 bbls.	$4 mln.	Planned				
Mississippi River Fuel Co.	Star City, Ark.	Comp. Sta.	5,000 hp.		Completed			Ref. Maint.	Ref. Maint.
Mississippi River	Pocahontas, Ark	Comp. Sta.	5,000 hp.		Completed			Ref. Maint.	Ref. Maint.
Mississippi River	Fredericktown, Ark	Comp. Sta.	4,000 hp.		Under Constr.	May, 1950		Ref. Maint.	Ref. Maint.
National Co-Op. Refinery Assn.	McPherson, Kans.	Polymerization, Fluid Cat. Crk., Add Tankage, Utilities	122,000 bbls.	$2 mln	Under Constr.		U.O.P.	Ref. Eng.	Ref. Eng.
Northern Nat. Gas	Sublette, Kans.	Gasoline Plant	265,000 mcf		Under Constr.	May, 1950			Pritchard
The Ohio Oil Co.	Lima, Ohio	Ref. Prdts Term.	200,000 gals.		Under Constr.	June, 1950			Poling & Bacon
Oklahoma Refg. Co.	Seminole, Okla.	Refinery	200 bbls.	$40,000					
Pan-Am Southern Corp.	El Dorado, Ark.	Delayed Coke Water Cooling Tower, Steam Gen. Boiler, Coke & Loading	9,300 bbls.		Planning	Oct., 1950		Lummus	Lummus
Petco Corp.	Blue Island, Ill.	Houdry, Cat. Crk., LPG Recov.	5,000 bbls.	$400,000	Under Constr.	Mid., 1950	Houdry	Houdry	Clarke, Cat. Constr.

For special conditions:

Anaconda Duplex Tubes

ANACONDA Duplex Heat Exchanger Tubes on request are supplied with the ends of the external tube cut back to receive ferrules for rolling into the tube sheet. Ferrules can also be supplied.

ANACONDA Duplex Tubes are available in a wide range of metals. These tubes can be supplied with the copper or copper alloy drawn either inside or outside of the steel tubing. For example, in a diethanolamine stripper, a copper-steel combination is called for, with copper on the outside of the tubes to resist corrosive steam and steel on the inside to resist attack by the amine.

For general information on ANACONDA Duplex Tubes write for Publication B-2. And remember that ANACONDA metallurgists are always ready to help you solve your tube problems. Address The American Brass Company, Waterbury 88, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 49180

For efficient heat transfer

ANACONDA Heat Exchanger Tubes

Natural Gasoline Corporation dries Propane to minus 50°F Dew Point with ALCOA Activated* Alumina

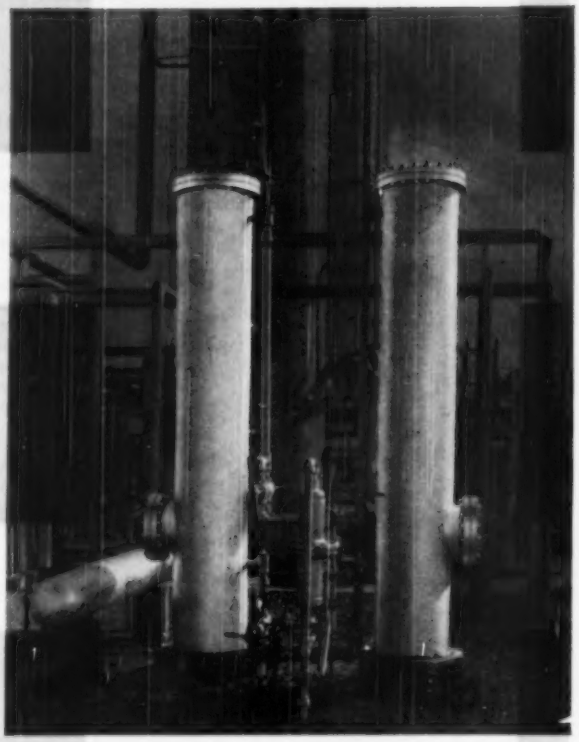
At the Hawkins, Texas, plant, operated by Natural Gasoline Corporation and owned jointly with Humble Oil & Refining Company, you'll find that ALCOA *Activated* Alumina has been drying propane efficiently since 1944. Entering the bottom of the towers at 90° F., 30,000 gallons of liquid propane is dehydrated daily to minus 50° F. at an operating pressure of 200 psig.

The unit operates on a 48-hour cycle, each tower being on stream 24 hours. Regeneration is accomplished in 18 hours by passing natural gas heated to 395° F. through the bed of alumina. Then 6 hours is allowed for cooling.

It is steady, reliable dehydrating performance such as this that has earned for ALCOA *Activated* Alumina a reputation as a dependable, economical desiccant. Commercially pure, it is one of the few solid adsorbents that does not change its form or properties. It will not swell, soften or disintegrate even when immersed in water, nor is it affected by shock or abrasion.

ALCOA *Activated* Alumina is non-corrosive and practically iron-free. It has no effect on the end product even when the two stand in contact for long periods.

If you dry gases, vapors or organic liquids, you'll want *all* the facts regarding this outstanding desiccant. We'll gladly show you how it can solve your particular drying problem. Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 617E Gulf Building, Pittsburgh 19, Pennsylvania.



Towers, in service since 1944, dry 30,000 gallons daily.

Alcoa Chemicals

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REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Petroleum Specialties, Inc.	Flat Rock, Mich.	Cat. Cracker	3,000 bbls.	$2 million	Planning	.....	.....	.....	.....
Phillips Petroleum	Okmulgee, Okla.	Cat. Poly Unit	.....	.....	Under Constr.	May, 1950	.....	Staff	Staff
Phillips Pet., et al	Edmond, Okla.	Add Nat. Gaso Plant	60,000 mcf	.....	Under Constr.	May, 1950	.....	.....	Ref. Maint.
The Shallow Water Refining Co.	Shallow Water, Kansas	Reforming Unit	1,400 bbls.	$225,000	Under Constr.	May, 1950	Pevco	Koch Eng.	Koch Eng.
Shell Oil Co.	Elk City, field Okla.	Gas Extrct. Plt.	100,000 mcf gas	.....	Contracted	End 1950	.....	Ref. Maint.	Ref. Maint.
Skelly Oil Co.	El Dorado, Kans.	Crd. Dist. Cat. Crk.	†35,000 bbls.	$8-10 million	Completed	.....	.....	.....	.....
Socony-Vacuum Oil Co.	E. St. Louis, Ill.	Thermal Crack.	13,200 bbls.	.....	Completed	.....	.....	Staff	Bechtel
Socony-Vacuum	E. St. Louis, Ill.	Miscel. Ref. Addn.	.....	.....	Completed	.....	.....	Staff, Bechtel	Bechtel
Socony-Vacuum	Augusta, Kans.	Houdry Conversion to T.C.C.	15,000 bbls.	.....	Contracted	End 1950	Socony-Vacuum	.....	.....
Socony-Vacuum	Trenton, Mich.	Houdry Conversion to T.C.C.	13,000 bbls.	.....	Contracted	End 1950	Socony-Vacuum	.....	Braun
Standard (Ohio)	Cleveland, Ohio	Houdry to TCC	18,000 bbls.	$4 million	Under Constr.	Nov., 1950	Socony-Vac.	Bechtel	Bechtel
Standard (Ohio)	Lima, Ohio	Clay Contact	2,400 bbls.	$1 million	Under Constr.	Mid., 1950	.....	Lummus	Lummus
Standard (Ohio)	Lima, Ohio	Inc. Tank. Cap.	215,000 bbls.	$240,000	Under Constr	May, 1950	.....	Staff	Hammond
Standard (Ohio)	Lima, Ohio	Furfural Unit	4,500 bbls.	$13 million	Under Constr.	Mid 1950	Texaco	Lummus	Lummus
Standard (Ohio)	Lima, Ohio	Solvent Dewax.	3,500 bbls.	$4.5 million	Under Constr.	Mid, 1950	Texaco	Lummus	Lummus
Standard (Ohio)	Lima, Ohio	Vacuum Unit	9,000 bbls.	$1 million	Under Constr.	Mid, 1950	.....	Lummus	Lummus
Standard (Ohio)	Lima, Ohio	Propane, Deasph.	800 bbls.	$1 million	Under Constr.	Mid. 1950	.....	Kellogg	Kellogg
*Sun Oil Co.	Toledo, Ohio	Expansion	70,000 bbls.	$22.5 mln.	Completed	.....	.....	.....	Cat. Constr.
The Texas Co.	Lawrenceville, Ill.	Expand Refinery	†20,000 bbls.	.....	Under Constr.	April, 1951	.....	Foster Wheeler, Kellogg	Foster Wheeler, Kellogg
Tide Water Associated Oil Co.	Drumright, Okla.	Houdriflow Unit Cat. Cracker	4,500 bbls.	.....	Under Constr.	Late May, 1950	Houdry	.....	Process Eng.
U.S. Dept. of Interior	Louisiana, Mo.	Demonstration oil-from-coal	80 bbls.	$5 million	Under Constr.	May, 1950	.....	Koppers	Koppers
Vickers Petroleum	Potwin, Kans.	Desalting	6,000 bbls.	.....	Under Constr.	June, 1950	.....	.....	.....
SOUTHWEST									
Alba Refg. Co.	Alba, Texas	Asphalt Refining	2,000 bbls.	$150,000	Under Constr.	Spring, 1950	.....	.....	.....
Calumet Refg. Co.	Princeton, La.	Blending Oil Tank House	700 bbls.	.....	Suspended	.....	.....	Staff	Staff
Carthage Hydrocol, Inc.	Brownsville, Texas	Hydrocol	87,000 mcf	.....	Under Constr.	Spring, 1950	Hydro-Res., Inc. Texaco	McKee, Hydro-Res., Inc.	McKee
Continental Assocs.	Near Nordheim, DeWitt County, Texas	Gas Comp.	12,000 mcf	$1 million	Completed	.....	None	Process Eng.	Process Eng.
Del Rey Petroleum Co.	Chesterville, Tex.	Pressure Absorption Plant	25,000 mcf	.....	Under Constr.	.....	.....	O. L. Olson	Ole Olson
Dow Chemical Co.	Freeport, Texas	Ammonia Plant	100 tons	$5 million	Planning	Late 1950	.....	.....	Austin
El Paso Natural Gas.	Crane County, Texas	Compressor Sta.	4,400 hp.	$1.27 million	Under Constr.	June, 1950	.....	Staff	Staff
E. I. DuPont de Nemours Co., Inc.	Victoria, Texas	Chemical Intermediate for Nylon	.....	.....	Design	Early 1951	.....	Staff	Staff
Esso Standard Oil Co.	Baton Rouge, La.	Main Office, Cafeteria, Crude Desalting Unit	.....	.....	Under Constr.	May, 1950	.....	Bodman & Murell, Staff	Staff, Harris
Fullerton Oil Co.	Snyder, Texas	Refrig. Nat. Gaso. Plt.	40,000 mcf	.....	Contracted	July, 1950	.....	.....	Hudson
Humble O&R	Baytown, Texas	Roof Replacing of Butyl Bldg.	.....	.....	Under Constr.	Aug., 1950	.....	Staff	Tellepsen
Humble O&R	Baytown, Texas	Miscl. Facilities	.....	$1 million	Projected	.....	.....	.....	.....
Humble O&R	Jourdanton Field, Texas	Gasoline Plant	26,000 mcf	.....	Under Constr.	July, 1950	.....	.....	Hudson
Humble O&R	Baytown, Texas	Research Bldg.	.....	.....	Under Constr.	Aug., 1950	.....	Voorhees-Walker	Knutson
Humble O&R	Baytown, Texas	Mech. Maint. Bldg.	.....	.....	Under Constr.	Oct., 1950	.....	Ferguson	Bellows
Magnolia Pet.	Beaumont, Tex.	Thermofor Cat. Cracker	15,000 bbls.	.....	.....	1950	.....	.....	.....
Magnolia Pet. Co.	Beaumont, Tex.	Two Houdry's to T.C.C.	30,000 bbls.	.....	Authorized	Late 1950	.....	.....	Lummus
Magnolia Pet. (Operator) et al.	Lobita-La Ward, Jackson County Texas	Comp. Sta.	15,000 mcf	.....	Under Constr.	May, 1950	.....	West	West
Matheson Chem. Co.	Pasadena, Texas	Fertilizer Plt.	.....	.....	Under Constr.	1950	.....	Owner	.....
McMurray Refining Co.	Tyler, Texas	Fluid Cat Cracker, Gas-Conc., Feed Prep. & Cycle-Oil Crk.	5,000 bbls.	.....	Planned	Fall, 1950	.....	U.O.P.	U.O.P.
North American Oil Consolidated & Ungren & Frazier.	Bartlett Field, Jones County,	Gaso. Plt., Gas Injection Facilities.	.....	.....	Planning	.....	.....	.....	.....
Pan Am. Ref.	Texas City, Tex.	Desulfo Unit	.....	$25,000	Under Constr.	Spring, 1950	.....	Tellepsen	Tellepsen
Pan Am. Ref.	Texas City, Tex.	Lab., Pilot Plt. Additions	.....	.....	Under Constr.	Spring, 1950	.....	Ferguson	Ferguson
Pontiac Refining Co. & Chicago Corp.	Corpus Christi, Texas	Ref. Petro-chem. Plt.	5,000 bbls. gaso., 170,000 bbls. ethylene glycol, 3,000 lbs. ethylene	$15 million	Design, Planning	Mid., 1951	.....	.....	.....
The Pure Oil Co.	Dollarhide, Andrews Co., Tex	Nat. Gaso. Plt.	22,000 mcf	$6 million	Under Constr.	July, 1950	.....	.....	Hudson
Shamrock Oil & Gas Co.	Sunray, Texas	Houdri. Cat. Crk.	5,000 bbls.	.....	Under Constr.	Early 1951	Houdry	.....	Cat. Constr. (Philadelphia)
Shell Oil Co.	Provident City, Texas	Gas Stripping	60,000 mcf	$2.5 mnl.	Under Constr.	May	.....	Fluor	Fluor
Standard (Texas)	7 mi N Snyder, Scurry Co., Texas	Gaso. Absorp. Plt.	30,000 mcf	$2-3 million	Planning	Mid., 1950	.....	.....	.....
Standard O&G	Brownsville, Tex.	Chemical Plant	150 tons	.....	Under Constr.	May, 1950	.....	Badger	Badger
Standard O&G	N. Cowden, Tex.	Gasoline Plant	50,000 mcf	.....	Completed	.....	.....	Stearns-Roger	Stearns-Roger
The Texas Co.	Tijerina-Canales Field, Texas	Gas Compression	3,000 mcf	.....	Under Constr.	July, 1950	.....	.....	.....
United Gas Pipe Line Co.	Karnes City, Texas	Nat. Gas., Condensate Process	10,000 mcf	$1 million	Under Constr.	May, 1950	.....	Delta	Delta
United Gas Pipe Line	Sterlington, La.	Dehydration	†25,000 mcf	.....	Under Constr.	.....	.....	.....	Staff
ROCKY MOUNTAIN									
Frontier Refining Co.	Cheyenne, Wyo.	2 Coke Crks.	3,500 bbls	$725,000	Contracted	June, 1950	U.O.P.	Ref. Eng.	Ref. Eng.
*Pan-Am Southern	El Dorado, Ark.	Cat. Crk., Vap. Recov.	9,000 bbls.	.....	Contracted	April, 1951	.....	.....	Foster Wheeler
*Pan-Am.	El Dorado, Ark.	Coking unit	.....	.....	Under Constr.	Sept., 1950	.....	Lummus	Foster Wheeler
Salt Lake Refining Co.	Salt Lake City	Cat. Cracking	25,000 bbls.	$10 million	Authorized	Jan., 1951	Houdry	Bechtel-Houdry	Bechtel

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Sioux Oil Co.	Newcastle, Wyo.	Thermal Crk.	1,200 bbls.	$300,000	Under Constr.	Spring, 1950	U.O.P.	Koch	Staff
Sioux Oil Co.	Newcastle, Wyo	Cat. Poly.	60 bbls.	$100,000	Under Constr.	Spring, 1950	U.O.P.	Koch	Staff
Socony-Vacuum Oil Co.	Casper, Wyo.	Topp. Revisions	5,900 bbls.		Completed			Staff	Cat. Constr.
WEST COAST									
Continental Oil Co.	Ventura, Calif.	Rev. to Gaso. Plt.	20,000 mcf		Under Constr.	May, 1950		Ref. Maint.	E. & A. Ref.Maint.
General Petroleum	Torrance, Calif.	Add Odor Abate. System		$60,000	Under Constr.	May, 1950		Staff	Staff
General Petroleum	Torrance, Calif.	Dust Collecting Sys. to Gaso. Cat. Crk.		$35,000	Under Constr.	May, 1950		Staff, Ref. Maint.	Ref. Maint.
General Petroleum	Torrance, Calif.	Smoke, Fume, Odor Contrls		$250,000	Under Constr.			Staff	
*General Petroleum	Torrance, Calif.	Cat. Crk., Fur.	4,000 bbls.		Authorized				Lummus
*General Petroleum	Torrance, Calif.	Coker	7,500 bbls.		Completed				
Hancock Oil Co.	Long Beach	Ethylene Glycol	60,000 lbs.		Considering			Badger	Badger
Paloma Refining Co.	Paloma Field, Calif.	Ext. Atmp. Sect.	60,000 mcf		Under Constr.	June, 1950			
Richfield Oil Corp.	So. Cuyama, Calif.	Atmp. & Comp. Plt.	30,000 mcf		Under Constr.	May, 1950		Fluor	Fluor
Stancal Asphalt & Bitumuls Co.	Point Wells, Wash.	Asphalt Refinery			Under Constr.	Mid., 1950			
Standard Oil (Calif.)	Richmond, Calif.	Vac. Tower T.C.C. Conv.	55,000 bbls. 45,000 bbls.	Engineering	Approved Under Constr.	May, 1951 Mid., 1951	Houdry	Staff	Bechtel
Union Oil Co. of Calif.	Bren Olinda, Cal.	Research Plant		$5 million	Projected	Sept., 1950			
Union Oil of Calif.	Oleum, Calif.	Revise Refg.		$4 million	Under Constr.	Spring, 1950		Parsons, E. & A.	Ref. Maint.
Union Oil of Calif.	Oleum, Calif.	Improve Handling Facilities		$1.5 million	Under Constr.	Spring, 1950		Mathews, Montgomery	Early, C. N. Peterson, Mathews
Union Oil of Calif.	Oleum, Calif.	Tankage and Utilities		$1.8 million	Under Constr.	Spring, 1950		Parsons	Eaton & Smith, C.B.&I., Utah
Union Oil of Calif.	Oleum, Calif.	Add Main Office Shops		$1 million	Under Constr.	Spring, 1950		Austin, Field & Fry, D. R. Warren Co., Montgomery	E. S. McKittrick, Parker, Steffen & Pearce
Union Oil Co.	Oleum, Calif.	Add Ref. Facits.			Under Constr.	Spring, 1950			
FOREIGN									
Canada									
British-American Oil Co.	Edmonton, Alberta	Refinery	6,000 bbls.		Contracted	Early, 1951		Can. Kellogg	Can. Kellogg
British-American Oil	Clarkson, Ontario, Can.	Propane Deasphalt.	700 bbls.	$400,000	Under Constr.	Mid., 1950	S.O.D., Union Oil (Calif.), Standard(Ind.)	Canadian Kellogg	Canadian Kellogg
Excelsior Refs., Ltd.	Lloydminster, Alberta	Cap. Increase	3,000 bbls.		Under Constr.	1950			
Excelsior Refs., Ltd.	Lloydminster	Capacity Inc.	1,500 bbls.		Design	1950			
Imperial Oil, Ltd.	Leduc Field	Gas Absorption	24,000 mcf	$6.5 million	Under Constr.	Mid. 1950		Braun	Braun
Imperial Oil	Winnipeg	New Refinery	10,000 bbls.	$10 million	Planning	May, 1951		Canadian Kellogg	Canadian Kellogg
*McColl Frontenac Oil Co., Ltd.	Edmonton, Alta.	Crd. Processing Cat. Crk.	5,500 bbls.	$10 mln.	Contracted	1951		Foster Wheeler	Foster Wheeler
Panther Oil and Grease Co.	Leaside, Toronto, Ontario	Grease and Compounding			Projected				
Shell Oil Co. of Canada, Ltd.	Montreal East, Quebec	Fluid Cat. Crk., Vac. Flash Gas Recov., Poly, Treat	35,000 bbls.		Under Constr.	Late 1950		Staff	Fluor, Ltd., McKee
Supreme Refineries, Ltd.	Hanna, Alt.	Nat. Gaso. Plt.	1,000 mcf.	$100,000	Contracted	June, 1950		Staff	Staff
Supreme Refineries	Ogden, Alt.	Refinery	1,000 bbls.	$100,000	Under Constr.	June, 1950		Staff	Staff
Latin America									
Administracion Nacional Combustible Alcohol y Portland	Montevideo, Uruguay	Lube, Asphalt Units	7,500 bbls.		Under Constr.	2nd Qtr., 1950		Foster Wheeler	Foster Wheeler
Conselho Nacional do Petroleo	Mataripe, Bahia, Brazil	Thermal Cracking Refinery	2,500 bbls.	$5 million	Under Constr.	Dec., 1950		Kellogg	Kellogg, Staff
Conselho Nacional do Petroleo	Cubatao Sao Paulo, Brazil	Therm. Crk. Ref.	45,000 bbls.		Designing			Hydrocarbon	Fives-Lille & Schneider, Staff
Conselho Nacional do Petroleo	Mataripe, Bahia, Brazil	Ref. Expn.	2,500 bbls.	$3.5 million	Planning	Dec., 1950			
Creole Pet. Corp.	El Roble Field, Venezuela	Repressuring			Planning				
Ipiranga S.A. Cia Brasileira de Petroleos	Rio Grande, Brazil	Therm. Crk. Ref.	2,000 bbls.		Authorized	1952	Foster Wheeler		
Mene Grande Oil Co.	Puerto la Cruz, Venezuela	Refinery	30,000 bbls.						
Petroleos Mexicanos	Poza Rica, Mex.	Gas Purification Pressure Maint.		$13 million	Under Constr.	Dec., 1950		McKee	McKee
Petroleos Mexicanos	Salamanca, Mex.	Crd., Gasoil, Crk.	25,000 bbls.	$12 million	Under Constr.	Aug., 1950	U.O.P.	McKee	McKee
Petroleos Mexicanos	Reynosa, Mex.	Refinery	4,000 bbls.	$1 million	Under Constr.	Jan., 1951		Staff	Staff
Phillips Oil Co.	San Roque Fld., Anzoategui, Ven.	Refinery, Wax Plt.	2 mln lbs. Wax/year		Planning	1952			
Puerto Rican Oil Refining Co.	Near Ponce, Puerto Rico	Refinery	25,000 bbls.	$20 million	Projected	1st Qtr., 1951	Undetermined	Parsons, Brinckerhoff, Hall and Macdonald	
Refinaria de Petroleo do Distrito Federal S.A.	Rio de Janeiro, D. F. Brazil	Therm. Crk.	10,000 bbls.		Authorized				Fives, Lille, Schneider, Staff Foster Wheeler
Refinaria e Exploracao de Petroleo Uniao S.A.	Capuava, Sao Paulo, Brazil	Therm. Crk. Ref.	20,000 bbls.		Authorized			P. A. Hydro. Res.	Czech. Fact. Metal Work Mech. Constr.
Richmond Exploration Co.	Bajo Grande, Venezuela	New Refinery	35,000 bbls.		Engineering	June, 1950			
Shell Caribbean Pet. Co.	La Paz, Venezuela	Gas Plant	90 tons		Under Constr.	Spring, 1950			
Shell Caribbean Pet.	Mara, Ven.	Gas Plant	90 tons		Projected	Early 1951			
Venezuelan Gulf Refining Co.	Puerto la Cruz, Venezuela	Refinery	30,000 bbls.	$50 million	Completed			Lummus	Lummus
Venezuelan Pet. Co.	Puerto la Cruz, Venezuela	Refinery	35,000 bbls.		Under Constr.			Snare	Snare
Yacimientos Petroliferos Fiscales	Buenos Aires, Argentina	New Refinery	28,000 bbls.	$54 million	Engineering	Late 1950		Kellogg	Kellogg

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company "Bridgeport" *Headquarters for BRASS, BRONZE, and COPPER*

Duplex Tubing Licks Mean Corrosion Problem

Replaces Steel Tubing in Ammonia Condenser for Longer Life and Reduced Maintenance

Increasing use of ammonia in gas and liquid forms in petro-chemical processing, refrigeration, cooling, and condensing applications has greatly aggravated the corrosion problem for operating engineers.

Ammonia is very corrosive to copper and most of its alloys, but is inert to iron and steel. This explains why ammonia is often handled in containers and pipes made from steel.

However, since transfer of heat is generally involved in ammonia refrigeration systems, steel piping is subject to excessive corrosion from contact with the water side or from condensation of moisture from the atmosphere. Recent use of Duplex Tubing, with steel to the ammonia side and copper or brass to the water side, has greatly reduced this corrosion problem.

The ammonia condenser illustrated was rebuilt by Ohmstede Machine Works for Magnolia Petroleum Company. Here 2" O.D. Duplex Tubing, combining 16 BWG steel outside, and 12 BWG Arsenical Admiralty brass inside was used. Admiralty was chosen because of its resistance to corrosion from brackish river water sometimes circulated in the Magnolia refinery at Beaumont, Texas.

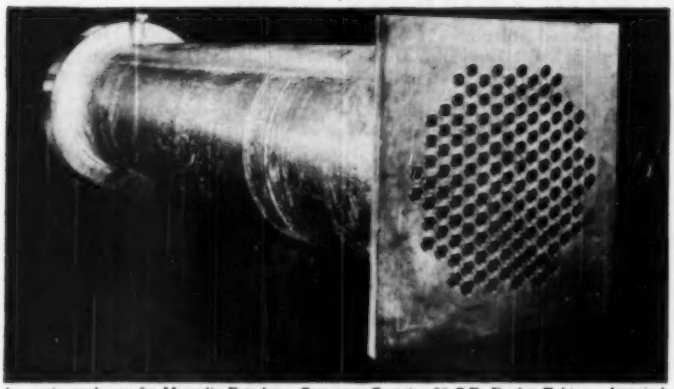
Avoiding Galvanic Corrosion

In order to reduce both corrosion and galvanic attack to a minimum, every effort was made to confine the circulating water to the copper alloy side and the ammonia gas to the steel side. It was, therefore, necessary to cover the outside of the steel tube sheet with a naval brass plate. The ends of the Duplex Tubes were cut back on the outside for a distance of ½" and replaced with a sleeve of Admiralty tubing of the same dimensions as the steel section removed. This is illustrated in the accompanying sketch.

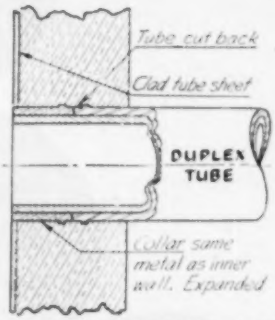
The Duplex Tubing was rolled into the tube sheet making a tight connection in order to confine the ammonia gas which may attain a pressure of 250 psig.

Improved Heat Transfer

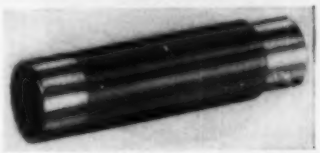
Duplex Tubing in ammonia refrigeration systems greatly outlives steel tubing formerly used. Furthermore, a much higher heat transfer efficiency is



Ammonia condenser for Magnolia Petroleum Company. Contains 2" O.D. Duplex Tubing -- Arsenical Admiralty inside and carbon steel outside. Rebuilt by Ohmstede Machine Works, Beaumont, Texas.



obtained with Duplex Tubing since the development of heat insulating layers of rust on the water side is avoided through the use of a copper base alloy. Maintenance, cleaning and shutdown time are markedly reduced.



A small sample of Duplex Tubing cut back at both ends, one covered with a sleeve of the same metal as the inside component.

Very difficult corrosion problems such as are experienced in the chemical and refinery fields are often solved through the use of Duplex Tubing which can be made in many combinations of metals. For example, to resist various intensities of corrosive attack from the water side, a variety of copper-base alloys such as Arsenical Copper, Muntz metal, Admiralty Brass, Aluminum Brass, Red Brass, Aluminum Bronze, and several Cupro Nickels are available. On the product side, low carbon steel, stainless steel, Monel metal, aluminum, lead, nickel, tin and all of the copper-base alloys can be used to meet specific types of corrosive attack.

Since new products and changes in processing bring new corrosion problems, our corrosion laboratory will be glad to work with designers and operators to determine the type of tubing which will give the most satisfactory service life. Contact our nearest Sales Office for any help which we can render.

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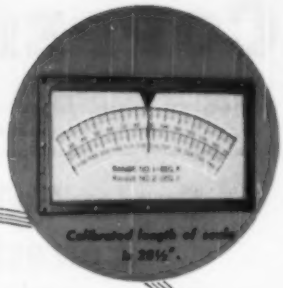

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REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
YPF	La Plata, Argentina	Crude Topping, Gaso Treating	50,000 bbls.	$2.6 million	Under Constr.	Spring, 1950		Houdry Process Cat. Constr.	Cat. Constr.
YPF Boliviana	Cochabamba, Bolivia	Topping & Reforming Units	5,000 bbls.			3rd Qtr., 1950		Foster Wheeler	Foster Wheeler
Europe and Africa									
Anglo-American Oil Co.	Fawley, Eng.	Refinery Expansion	110,000 bbls.	$150 million	Under Constr	Late 1952		Foster Wheeler	Foster Wheeler
Anglo-American	Fawley, Eng.	SO_2 Extraction	13,000 bbls.		Design			Badger	Badger
Anglo-Iranian Oil	Isle of Grain, Eng.	Cent. Refg. Unit	60,000 bbls.	$120 million	Planning	1952			
Anglo-Transvaal Consolidated Investment Co.	Vall River, Union of South Africa	Synthetic Gasoline and Diesel Oil Plant		$50-60 million	Contracted			Hydro. Res.	
Aquila, S.A.	Trieste, Italy	Lube Oil Ref.	800 bbls.	$7.9 million	Design	Mar., 1951	Juik, Texaco	Badger	Badger
Azienda Generale Italiana Petroli	Rome, Italy	Add to Plant	24,000 bbls.		Projected	Late 1951			
Azienda Generale Italiana Petroli	Palermo, Italy	Marine Fuel Plant	7,500 bbls.						
Batafsche Petroleum Mij.	Pernis, Holland	P. V. C. Plant	2,000 tons, yr.		Completed				
My. Batafsche Pet.	Pernis, Holland	Expansion	50,000 bbls.		Under Constr.	Mid 1952			
British Petroleum Chem.	Grangemouth, Scotland	Petrochem			Under Constr.	Dec., 1950		Stone & Webster	Stone & Webster
Cabot Carbon, Ltd. (Godfrey L. Cabot, Inc.)	Ellesmere Port, Eng.	Carbon Black Plant	50,000 lbs., yr.		Under Constr.	1950		Simon-Carves, Ltd.	Simon-Carves, Ltd.
Cie. de Raffinage Shell-Berre	Berre, France	Expansion	26,600 bbls.	$31.6 million	Under Constr.	Mid 1951			
Shell	Petit-Couronne	Teepol Plant	25,000 tons, yr.			Mid 1950			
Cie. de Raffinage Shell-Berre	Petit Couronne, France	Lube Unit			Planned				
Cie. de Raffinage Shell-Berre	Petit-Couronne (Rouen), France	Extension	10,000 bbls.		Under Constr.	2nd Qtr., 1950			
Cie. Francaise de Raffinage	Gonfreville, France	Lube Unit	2,500 bbls.		Design	1951	Texaco	Kellogg-Lummus	
Cie. Francaise de Raffinage	Gonfreville, France	Distillation Unit	20,000 bbls.		Under Constr.	3rd Qtr., 1950		Foster Wheeler	Foster Wheeler
Cie Francaise de Raffinage	Provence, France	Topping Unit	20,000 bbls.		Under Constr.	4th Qtr., 1950		Foster Wheeler	Foster Wheeler
Cia Espanola de Petroleos, S.A.	Sta. Cruz de Tenerife, Canary Islands	Propane-Butane Fractionating.	304 bbls.	$100,000	Contracted	Late 1950		U.O.P.	U.O.P.
C.E.P.S.A.	Canary Islands	Propane-Deas.	700 bbls	$300,000	Contracted	Late 1950	Standard Oil	Foster Wheeler	Foster Wheeler
C.E.P.S.A.	Canary Islands	Furf. Ref. Sol. MEK Dewax.	425 bbls.	$4.5 million	Under Constr.	Mid., 1950	Texaco	Foster Wheeler	Foster Wheeler
Condor, S.P.A. Per l Industriale Pet. Chemica	Rho, Italy	New Refinery	1 mln tons, yr.		Under Constr.				
Danish Government	Denmark	Refinery	21,000 bbls.		Planned				
Egyptian Government	Cairo, Egypt	Crude Plant						Lummus	Lummus
Industrie Chimiche Italiane Petroli	Mantua, Italy	Crude	4,500 bbls.						
Industria Nazionale Petroli e Trasformaniche	Massa Carrara, Italy	Refinery	40,000 bbls.			Late 1951			
Industria Petrolifera e Chimica	Milan, Italy	Gasoline Fuel Oil Plant	20,000 bbls.					Dr. Calogero Inglogio	
Imperial Chemical Industries, Ltd.	Wilton, Yorkshire, England	Petroleum Cracking Unit			Under Constr.	End 1950		Kellogg	Kellogg
L'Alliance Petrofina	Antwerp, Belg.	Refinery	21,000 bbls.		Planned				
Manchester Oil Refinery, Ltd.	Partington, England	Cat. Crk., Lube Reforming	20,000 bbls.		Projected				
Monsanto Chemical Co.	Britain	Add Polystyrene			Under Constr.	2nd Qtr., 1950		Staff	Staff
National Oil Refineries	Llandarcy, Wales	Furf. Ref. Sol. Dewax, Wax Fractn.	1,200 bbls.	$36 million	Designing	Early 1953	Texaco	Badger	Badger
National Oil Refineries	Llandarcy, Wales	SO_2 Solvent Extraction	3,000 bbls		Contracted	Early 1951		H.W.P.	H.W.P.
Pechelbronn, S. A. E. M.	Merkwiller, France	Capacity Increase	1,550 bbls.		Authorized	1950			
Petrocarbon, Ltd.	Partington, England	Cat. Cracker, Lube & Reform	20,000 bbls.						
Petro Chem., Ltd.	Partington, England	Petrochemicals	2,000 bbls.	$16 million	Under Constr.	2nd Qtr., 1950	Petro-Carbon	Petro-Carbon	Petro-Carbon
Philblack, Ltd.	Avonmouth, England	Carbon Blk. Plt.	137,000 bbls.	$5 million	Contracted	Aug., 1950	Phillips	H.W.P.	H.W.P.
Ref. de Pet. de Escom. S.A.	Escombreras, Spain	Add Refinery	20,000 bbls.		Under Constr.	Oct. 1, 1951			
Ref. Belge	Antwerp, Bel.	Atmos., Vac. Distill.	7,000 bbls.	$1.5 mln.	Planning	June, 1951			
Raffinerie Belge de Petroles S.A.	Antwerp, Belgium	Therm. Crk., Reform., Gas Plant	7,000 bbls.	$2 million	Under Constr.	June, 1950		Barnes	Barnes
Raffineries Francaises de Petrole de l'Atlantique	St. Nazaire, France	Consolidate Refineries	7,100 bbls.	$9.4 million					
Raffinerie Siciliane Oli Minerali, Sp.A.	Augusta, Sicily	Crude Refinery	10,000 bbls.		Under Constr.	July, 1950	U.O.P.	U.O.P., Delta, Staff	Staff
Scottish Oils, Ltd.	Grangemouth, Scotland	Stage I: 1 Pipe Still Distill., Steam Boil. & Power Plt.	1.5 mln. tons per Yr. 20,000 kw		Under Constr.	End 1950		Kellogg	Kellogg
Scottish Oils	Grangemouth, Scotland	Stage II: Cat. Crk., Vac. Distill., Cat. Poly Plt., & Trtng Plt			Planned	Mid., 1952			
Scottish Oils, Ltd.	Grangemouth, Scot.	Buoyancy Foundations			Under Constr.	End 1950		Rendel Palmer and Tritton	
Shell Chemical Mfg. Co., Ltd.	Thornton, Eng.	Teepol Plant Extension	75,000 tons per Year		Under Constr.	Spring, 1950			
Shell Refining & Marketing Co., Ltd.	Stanlow, Eng.	Comprehensive Refining	50,000 bbls.		Under Constr.	Early 1952			
Shell Refining & Marketing Co., Ltd.	Shell Haven, England	Comprehensive Refining	40,000 bbls.	$34 million	Under Constr.	Mid 1953			
Societe Generale des Huiles de Petrole	Lavera, France	LPG Units	25,000 bbls.		Under Constr.	Mid 1950	Kellogg	Kellogg	Staff
Societe Generale	Dunkirk, France	Crude Reform.	33,000 bbls.		Under Constr.	Mid 1951	Lummus, Kellogg	Lummus, Kellogg	Lummus, Kellogg

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Societe Generale	Dunkirk, France	Furf. Ref. Sol. Dewax., Wax Fractn.	2,400 bbls.		Under Constr.	Mid 1951	Texaco	Lummus	Lummus
Societe Generale	Dunkirk, France	1st Stage Crde., Crk. Refinery	6,000 bbls. 30,000 bbls.		Completed Under Constr.	Mid 1951		Kellogg	Kellogg
Societe Industrial Belgique de Petrole	Antwerp, Belgium								
Societe Raffinazione Oli Minerali (IROM)	Porto Marghera, Italy	Atmospheric & Vac. Distill., Acid Treat., Contract Filtration for Lube Oils, Electric Gen. Unit, Load. Facilities	11,600 bbls.	$6.6 million	Contracted			H.W.P.	H.W.P.
Societe per Azioni Raffineria Padana Oli Minerali	San Martino di Trecate, Italy	Refinery	13,000 bbls.		Proposed				†
Socony-Vacuum Francaise	Notre Dame de Gravenchon	MEK Unit	1,000 bbls.		Design	Mid 1950	Texaco	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon	Propane Deasphalting	1,100 bbls.		Design	Mid 1950	Juik	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon	Grease and Compounding			Under Constr.	Mid 1950		Staff	Staff
Socony-Vacuum Italiana, S.p.A.	Naples, Italy	Visbreaker				Fall, 1950		Staff	Staff
Socony-Vacuum Italiana, S.p.A.	Naples, Italy	Topping Unit	15,000 bbls.		Under Constr.	Fall, 1950		Staff	Staff
Socony-Vacuum Italiana, S.p.A.	Naples, Italy	Solvent Treating	1,000 bbls.		Completed		Texaco	Staff	Staff
Socony-Vacuum Italiana, S.p.A.	Naples, Italy	Reformer	5,000 bbls.		Completed			Staff	Staff
Stand.-Azienda Gen. Indro. Comb. (Stanic)	Leghorn, It.	Add Capacity	28,700 bbls.						
Ditto (Stanic)	Bari, Italy	Add Capacity	38,300 bbls.						
Standard Francaise des Petroles	Port Jerome, France	Dewaxing Plant	1,200 bbls	$6.4 million	Design	Late 1951		S.O.D.	Foster Wheeler
Standard Francaise des Petroles	Port Jerome, France	Deasphalting Plant	1,500 bbls.		Design	Late 1951		S.O.D.	
Standard Oil Co., (N.J.)	Belgium	Dist. Crack.	33,000 bbls.		Planned	Early 1952			
Trent Oil Prod. Development Co.	North Shields, England	Crude Plant	11,500 bbls.	$4.8 million	Plans approved				
Union Petrol Refinery, Ltd.	Johannesburg, Union of South Africa	New Refinery		$20 million	Projected				
Vacuum Oil Co., Ltd.	Coryton, Eng	Lube Refinery	20,000 bbls.	$30 mln.	Planned	Sept., 1952			
Near East									
Anglo-Iranian Oil	Abadan, Iran	Gas Plant	25,000 mcf	$2 million	Under Constr.	1950		Badger	Badger
Anglo-Iranian	Abadan, Iran	Cat. Cracker	30,000 bbls.		Under Constr.	1951		Foster Wheeler	Foster Wheeler
Anglo-Iranian	Abadan, Iran	Solvent Dewax.	700 bbls.		Under Constr.	4th Qtr., 1950	Texaco	Badger	Badger
Anglo-Iranian	Abadan, Iran	Gas Recov., Stab.	22,000 mcf		Under Constr.	Mar., 1951		Badger	Badger
Arabian American Oil Co.	Abqaiq, Saudi Arabia	Crude Oil Stabiliser	300,000 bbls.	$4.8 million	Under Constr.	Dec., 1950		Staff and Fluor	Fluor
Arabian American	Ras Tanura, S.A.	Asphalt Plant	500 bbls.	$1.25 mln.	Under Constr.	1950		Staff, Bechtel	Staff
Bahrein Pet. Co., Ltd.	Bahrein Island	Crd. Still Utl.	55,000 bbls.	$9.1 million	Under Constr.	Aug., 1950		Lummus, Bechtel	Int. Bechtel, Inc.
Consolidated Ref., Ltd.	Haifa, Palestine	Crude Plant	80,000 bbls.		Planned	Late, 1951		Badger	Badger
Consolidated Ref., Ltd.	Haifa, Palestine	Cen. Facilities			Under Design			Badger	
Consolidated Ref., Ltd.	Haifa, Palestine	Lube Plant	7,500 bbls.		Designing		Texaco, Juik	Lummus, Kellogg	Lummus, Kellogg
Far East									
Bataafsche Pet. Mij. (Shell)	Balikpapan, Borneo, East Indies	Expansion	42,000 bbls.		Under Constr.	Mid 1952			
Bataafsche Pet. Mij.	Pladjoe, Sumatra	Rehab. to Comprehensive Refg	70,000 bbls.		Under Constr.	Mid 1951			
Burmah Oil Co., Ltd.	Syriam, Burma	Furf., Sol. Dewax., Wax Mfg.	1,000 bbls.	$600,000	Designing		Texaco	Badger	
Burmah Oil Co.	Syriam, Burma	Thermafor Clay Revivification	66 tons	$150,000	Engineered	1950	Max Miller, Socony-Vacuum	Max Miller	
Pacific Refineries, Ltd.	Honolulu, Hawaii	Butane, Asph., Gas Oil, Lt. Freins. Refy.	3,000 bbls.	$1.5 million	Contracted	June, 1950		Fish Eng	Fish Eng
Ton Nenryo Kogyo, Ltd.	Schimizu, Japan	Refinery	4,000 bbls.		Completed				Staff
Ton Nenryo Kogyo, Ltd.	Wakayama, Japan	Topping	6,000 bbls.		Completed				Staff
Oceania									
Australian Shell Oil Co.	Clyde, New S. W., Australia	Lubsil Refining	250 bbls.		Under Constr.	Late 1950			
Australian Shell Oil Co.	Geelong, Victoria, Australia	New Refinery		$4.8 million	Under Constr.	Late 1951			
Australian Shell Oil Co.	Geelong, Victoria, Australia	Bitumen and Lubsil Plant			Projected				
Australian Shell Oil Co.	Geelong, Victoria, Australia	Asphalt, Lube Sol. Extct Plt.							

* First appearance in tabulation. † Added capacity.

NOTE: Austin—Austin Co. Badger—E. B. Badger & Sons. Barnes—W. M. Barnes & Co. Bechtel—Bechtel Corp. Bellows—W. S. Bellows Co. Blaw-Knox—Blaw-Knox Construction Co. Bowden—W. H. Bowden. Braun—C. F. Braun Co. Brown Eng.—Brown Engineering Co. Brown & Lite—Brown & Lite Co. Brown & Root—Brown & Root Construction Co. Can. Kellogg—Canadian Kellogg Co. Cat. Constr.—Catalytic Construction Co. Chemico—Chemical Construction Co. C.B.&I.—Chicago Bridge & Iron Works Co. Clarke—Clarke Construction Co. Constr. Service—Construction Service Co. Dresser—Dresser Engineering Corp. E.&A.—Ehrhart & Arthur, Inc. Ferguson—H. K. Ferguson. Fish Eng.—Fish Engineering Corp. Fluor—Fluor Corp. Foster Wheeler—Foster Wheeler Corp. Gasc. Plant—Gasoline Plant Construction Co. General American—General American Transportation Co. Girdler—The Girdler Corp. Graff—Graff Engineering & Equipment Co. Grebe & Doremus—Grebe & Doremus Process Co. Hammond—Hammond Iron Works Co. Harris—John W. Harris Associate, Inc. Houdry—Houdry Corp. Howard-Mitchell—Howard-Mitchell Construction Co. Hudson—Hudson Engineering Corp. H.W.P.—Head Wrightson Process, Ltd. Hydro Res.—Hydrocarbon Research, Inc. Ind. Eng.—Industrial Engineers, Inc. J.&L. Constr.—Construction Division, Jones & Laughlin Supply Co. Kellogg—M. W. Kellogg Co. Koch—Koch Engineering Co. Koppers—Koppers Co., Inc. Knowles—Morris Knowles & Co. Knutson—Knutson Construction Co. Leonard—Leonard Construction Co. Lummus—The Lummus Co. Mahoney—Mahoney Contracting Co. Mason—Mason Brothers Construction Co. Mathews—Mathews Conveyor Co. McKee—Arthur G. McKee Co. Max Miller—Max B. Miller & Co. Michael Poling—Michael-Poling Construction Co., Inc. Montgomery—J. M. Montgomery & Co. P. A. Hydro Res.—Pan American Hydrocarbon Research, Inc. Parsons—The Ralph M. Parsons Co. Perco—Division Phillips Petroleum Co. Pet. Eng.—Petroleum Engineering, Inc. Petreco—Petroleum Rectifying Co. Pritchard—J. F. Pritchard Co. Pro. Eng.—Process Engineers, Inc. Process Constr.—Process Construction Co. Ref. Eng.—Refinery Engineering Co. Ref. Maint.—Refinery Maintenance Co., Inc. Rust Eng.—Rust Engineering Co. Rust Pro.—Rust Process Design Co. Schneider—Schneider & Co. Snare—Frederick Snare Corp. Sollitt—Summer S. Sollitt Co. S.O.D.—Standard Oil Development Co. State Eng.—State Engineering Co. Stearns-Roger—Stearns-Roger Manufacturing Co. Stone & Webster—Stone & Webster Construction Co. Tellepsen—Tellepsen Construction Co. Texaco—Texaco Development Co. U.O.P.—Universal Oil Products Co. Utah—Utah Construction Co. Voorhees, Walker, Foley & Smith. Walco—Walco Engineering. West—F. S. West Construction Co. White—J. H. White Eng., Corp. Wohfeld—Wohfeld Construction Co. Equally owned California Texas Corp. and Socony-Vacuum Oil Co., Inc.

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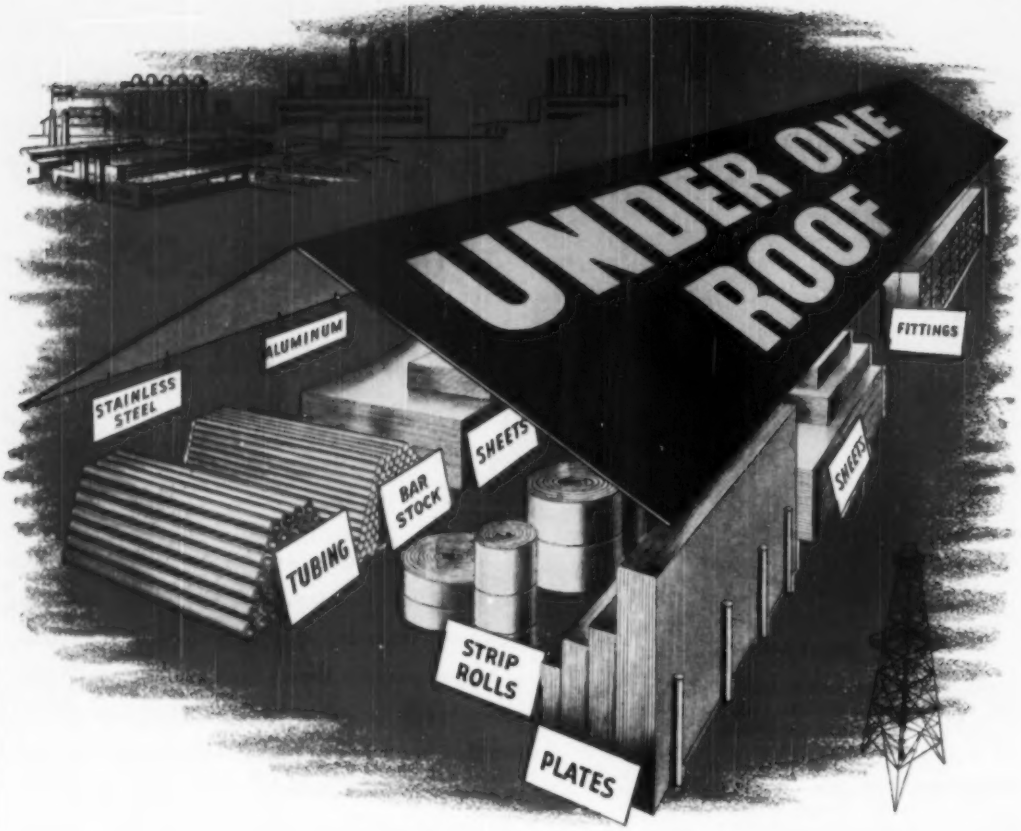

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PETROLEUM
REFINER
MAY, 1950

Figure 2. Exterior of Shop-Building Area, Shell Oil Company Houston Refinery.

Refinery Shop—Layout and Operation

ROBERT HALDANE
Chief Engineer, Houston Refinery,
Shell Oil Company, Houston

FOR SOME years past practically all industry has been faced with the problem of trying to squeeze out a reasonable profit from operations in which the cost of production, labor, equipment, material, and similar has increased out of all proportion to the prices obtainable for finished products. This has necessitated careful analysis of all phases of operations so that inefficiencies can be located and eliminated. Because, normally, industry's revenue is in return for the quantity and quality of products manufactured and sold, manufacturing methods are under constant scrutiny by management for possible improvement. Maintenance, however, is a very different matter. The usual tendency is to consider maintenance as a necessary evil—a stepchild, so to speak, which gets what is left of capital appropriations allocated for improvements only after the favorites have obtained their "take"—which they justify on the basis of tangible early payouts.

Such a justification is relatively easy for operations wherein it is possible to estimate the return accurately, based on improved and additional salable products. Consequently, the maintenance engineer is up against tough competition, for he must justify his capital expenditures largely on intangibles. Usually he has little difficulty convincing management that better working conditions—i.e., adequate lighting, pleasant surrounding, air conditioning, and similar—improve morale and worker efficiency. However, the question always is: how much improvement?—and it had better be plenty, for therein lies the payout for the improvements! Certainly, process and product improvements must be taken care of, because ultimately they determine the income. This is as it should be; but it is also easy to neglect, or to overlook, the possibility of improvements in maintenance—which are of equal importance.

By "equal importance" is meant that the gains which result from product improvement, or from improved manufacturing methods, may be offset by higher maintenance costs. Improved maintenance facilities result in a leveling off of the trend toward higher maintenance costs—even an actual reduction in such costs. With this in mind, approval to construct complete new facilities to replace those which had been in service at the Houston refinery was obtained.

This paper was before a session on refinery maintenance during the mid-year meeting of the API's division of refining, held early this month in Cleveland, Ohio. Mr. Haldane is chief engineer at Shell Oil Company's Houston refinery.

SHELL Oil Companys' Houston refinery was originally constructed, in 1929, for a crude intake of 26,000 barrels per day, and the shop facilities were designed to support a refinery of that capacity. Since that time the refinery's capacity has practically quadrupled—with an increase of approximately 25 percent in shop space and capacity. The old shops and working spaces were scattered within an area of some 375,000 square feet, as indicated in Figure 1. Included in this was a total shop area of 26,000 square feet, with the remainder consisting of outside working space. This was entirely unsatisfactory for the job at hand. Furthermore, the movement of material and equipment to be repaired pro-

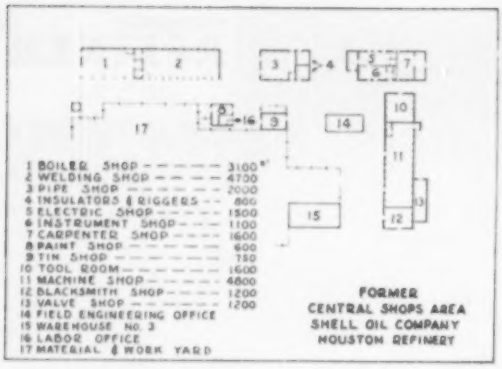

1 BOILER SHOP - - - - - - 3100
2 WELDING SHOP - - - - - - 4700
3 PIPE SHOP - - - - - - - - 2000
4 INSULATORS & RIGGERS - - 800
5 ELECTRIC SHOP - - - - - - 1500
6 INSTRUMENT SHOP - - - - 1100
7 CARPENTER SHOP - - - - - 1600
8 PAINT SHOP - - - - - - - - 600
9 TIN SHOP - - - - - - - - - 750
10 TOOL ROOM - - - - - - - - 1600
11 MACHINE SHOP - - - - - - 4800
12 BLACKSMITH SHOP - - - - - 1200
13 VALVE SHOP - - - - - - - - 1200
14 FIELD ENGINEERING OFFICE
15 WAREHOUSE NO. 3
16 LABOR OFFICE
17 MATERIAL & WORK YARD
FORMER
CENTRAL SHOPS AREA
SHELL OIL COMPANY
HOUSTON REFINERY

Figure 1. Former Central Shops Area at Houston.

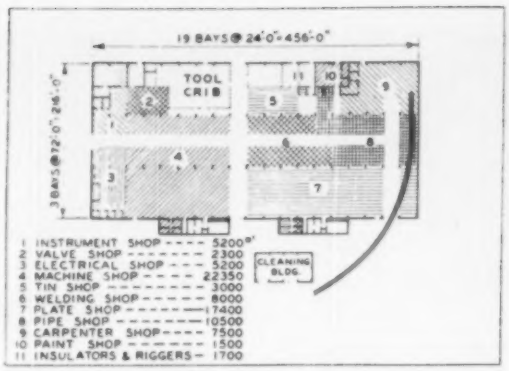

19 BAYS @ 24'0" = 456'-0"
3 BAYS @ 72'0" = 216'-0"
TOOL CRIB
CLEANING BLDG.
1 INSTRUMENT SHOP - - - - 5200
2 VALVE SHOP - - - - - - - - 2300
3 ELECTRICAL SHOP - - - - 5200
4 MACHINE SHOP - - - - - 22350
5 TIN SHOP - - - - - - - - - 3000
6 WELDING SHOP - - - - - - 8000
7 PLATE SHOP - - - - - - - 17400
8 PIPE SHOP - - - - - - - - 10500
9 CARPENTER SHOP - - - - 7500
10 PAINT SHOP - - - - - - - 1500
11 INSULATORS & RIGGERS - 1700

Figure 3. Maintenance Shops of Shell's Houston Plant.

ceeded in a cumbersome, time-consuming, and expensive manner. Devices such as wheelbarrows, scooters, trucks, and the like were used to transport equipment and material from one shop to another. This resulted in very unsatisfactory job planning and scheduling. In many instances it was necessary for field supervisors to follow a piece of equipment from one shop to another so that they could be sure it was being worked on. Thus their valuable time was wasted which could have been utilized to better advantage elsewhere.

In the new shop all maintenance activities are included under one roof with the exception of the labor department, which requires space only for supervisors' offices and laborers' equipment such as shovels, picks, weed cutters, etc., and the cleaning building. With the exception of the electronics room (in the instruments section) and the paint room, there are no partitions between the craft areas. The reason for this is to permit observation of the entire shop from any point, so that the handling of materials and equipment may be facilitated, and so that flexibility of the craft areas may be provided as it is needed.

Description of Shop

The main shop building is of structural steel and corrugated transite, with an 8-foot wainscoting of buff brick; and it has a flat roof. The building is air-conditioned throughout. Overall dimensions are 216 feet by 456 feet. There are 98,000 square feet of net floor area, including interior offices and drives. Actual shop space approximates 82,000 square feet, of which 12,000 square feet are allocated to heavy storage. Illumination is by combination mercury-vapor and incandescent lamps. There are continuous hammered-glass lights in the upper section of the north and south walls only. The east and west walls, which are long, are without glass so as to guard against sun-ray eye strain. The 3 bays in the building are 72 feet wide, each equipped with a bridge crane. In 2 of the bays the inside clear height to the roof is 34 feet, and in the third bay it is 24½ feet. Two identical extensions on the east side contain foremen's offices and separate washrooms for foremen and craftsmen. Offices for other supervisory personnel are located adjacent to individual craft areas within the building.

One building, which is used with the shop itself, is separate from the main building; this is the cleaning building. It has the same architectural treatment as the main shop building. It is not air-conditioned, but is heated by warm-air circulation. The overall dimensions are 40 by 80 feet, with 3,000 square feet of net floor area. There is a 15-ton bridge crane on rails, 18 feet above the floor level.

Figure 2 shows the exterior of the shop-building area, and Figure 3 illustrates the plan of the interior.

Lighting

A light intensity of 35-foot candles at floor level is provided throughout the shop by two hundred and twenty-two 750-watt incandescent lamps, and the same number of 400-watt low-pressure mercury-vapor lamps mounted in pairs at the bottom chord of the roof trusses. The mercury-vapor lamps are useful for reducing the glare from the incandescent lamps, because of their relatively large area of light source and consequent low brightness. Their characteristic "shadowless" illumination is particularly helpful when metal surfaces are being worked on. The

Figure 4. Dynamic Balancers.

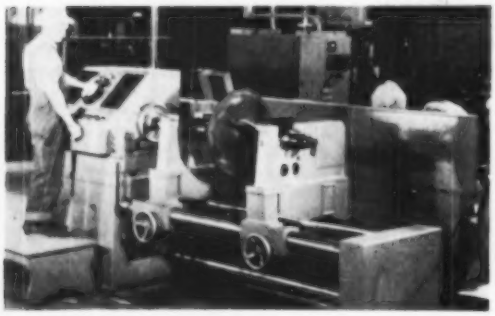
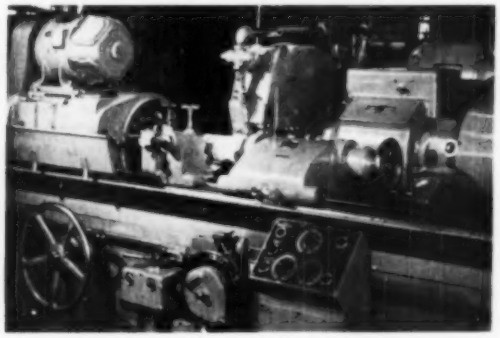


Figure 5. Cylindrical Grinder.



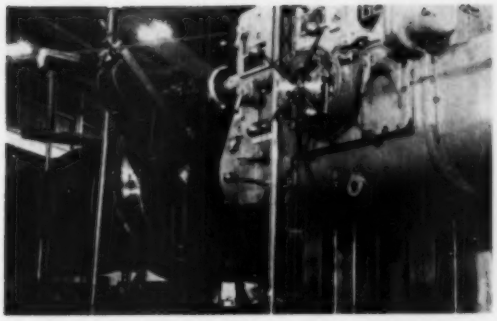


Figure 6. Large Heat-Exchanger Bundle in Horizontal Boring Mill.

Figure 7. Bins Picked up by Fork-Lift Truck.

offices, as well as the training, electronics, and paint rooms, are illuminated by flourescent lamps which provide a desk-level light intensity of 50-foot candles.

Paint Room

A water-spray booth, with a working volume 10 feet wide, eight feet deep, and 7 feet high, is installed in the paint room. The circulating-water system removes the undeposited paint from the booth exhaust—thus preventing its dissipation outside the shop building. The booth opening is provided with a filter to remove dust from the incoming air. Adjacent to the spray booth is a 12 by 18-foot drying room in which batteries of incandescent lamps are used for the rapid evaporation of solvent.

Cleaning Building

The primary purpose for providing a cleaning building is to reduce to a minimum the amount of dirt and oil brought into the shop building along with the work. When they require any cleaning, all pumps, heat exchangers, motors, castings, and similar are routed to the cleaning building before they are taken into the shop.

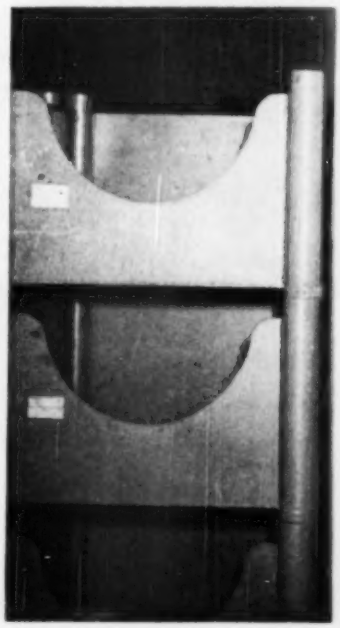
A 6-foot-diameter dipping vat, 17 feet deep, is recessed in the floor for the cleaning of heat exchangers, pumps, and large castings. Facilities are provided within the vat for circulation of liquid solvent, and for rotation of the article being cleaned. Smaller vats are also available for cleaning. A sandblasting chamber, 11 by 15 feet, is equipped with a sand- and grit-recovery conveyor, elevator and filter, a dust exchanger, as well as automatic filling of the sandblasting machine. All equipment is handled on dollies or by means of a 15-ton floor-operated bridge crane.

Shop Equipment

The shop is equipped with the most modern machinery available, a list of which is appended to this paper. Much of it is standard maintenance shop equipment, but there are a few items which deserve particular mention.

Because of the fact that there is so much rotating equipment in the plant —such as turbines, centrifugal pumps, blowers, electric motors, and similar— the need for dynamic balancing equipment justified the installation of two Gisholt dynamic balancers, one of which is illustrated in Figure 4. Experience with this equipment to date indicates that bearing failures, excessive vibration, and undue wear may be reduced or delayed by having the rotors balanced on the initial installation after a maintenance overhaul. Of course, it is recognized that, because of the corrosive nature of the products which are pumped and of the possibility of scale on the turbine blading, rotating equipment will not remain in balance; however, with a good balance to start with, the need for overhaul resulting from these conditions may be delayed, or the time between overhauls may be lengthened.

Figure 8. Bins Used in the Welding Section, One on Top of the Other.



Also, Figure 5 shows a cylindrical grinder, which is capable of grinding the surface of an eight-inch plug cock in 1½ hours. The old method, which used a grinding attachment on a lathe, took approximately 6 hours. In a refinery of this size there are numerous valves and plugs which require grinding. Furthermore, many pieces of equipment are hard-surfaced so as to provide wearing quality, and these are also ground on this machine.

Another piece of equipment which is more than paying its way is the horizontal boring mill. With this machine many cuts can be made on a piece of equipment with only a single setup. To set up a machine of this type is exceedingly time-consuming, and anyone familiar with this will appreciate the savings involved. Figure 6 illustrates a heat-exchanger bundle of considerable size which has been placed in this machine for resurfacing of the tube-sheet face. Without this modern equipment, this could be done only by disassembling the entire bundle. Originally, we did not have equipment in the old shops of sufficient capacity to lift this type of bundle, and the makeshift boring mill could not accommodate a piece of equipment of this size.

The foregoing represent three examples of what we are doing in the machine section to improve maintenance and to decrease maintenance costs. Numerous other examples might be given to illustrate similar savings resulting from the use of modern equipment in all the other sections.

In addition to the equipment just mentioned, Figure 13 is an interior view of the entire shop, taken from the south end; Figure 14 is a view of one of the bridge cranes; Figure 15 shows a basket, full of miscellaneous fittings, which is about to be dipped into a

Figure 9 (upper). Buff-Colored Identification Tag.
Figure 10 (lower). Shop Route Tags, Filled in by Expediter.

bath for cleaning; Figure 16 is the water paint-spray booth; Figure 17 shows the paint-drying room; Figure 18 illustrates the assembly section of the machine shop—showing special jigs for handling compressor valves; Figure 19 shows the automatic burning equipment—with a special stud-type table; Figure 20 shows one of the jib cranes in use; it is handling electrical motors in the electric section; Figure 21 shows the pump-disassembly section, with the pit for catching the pump drainings; Figure 22 is a view of the racks for storing heat-exchanger tubes, baffles, and tube sheets; Figure 23 is the hydraulic pipe-bending machine; Figure 24 shows the pipe-cutting and threading section. Note that a wooden curb has been placed around this section, and that the interior is filled with sawdust to absorb oil drippings.

Material Handling

The greatest advantage of having all shops under one roof, without partitions, is in the handling of equipment and materials. As has been mentioned previously, in the old shops the handling of equipment and materials was extremely inefficient. In order to eliminate time-consuming materials-handling inefficiencies, modern handling equipment has been provided.

Several types of equipment for handling materials are available. As mentioned previously, a traveling bridge crane is provided in each of the three bays. These are of 15, 10, and 5-ton capacity, and they operate the full length of the building on independently supported rails; the two larger cranes are both cab- and floor-operated, whereas the 5-ton unit is floor-controlled.

Throughout the building are located 20- and 30-foot electric-hoist 1-ton jib cranes, pivoted from the crane columns, where frequent handling of light materials and equipment is required. There are 13 cranes in place, and provision is made for future additions as required.

A gasoline-powered fork-lift truck is available for handling pallet and medium-weight material from bay to bay, and for delivery and loading of finished work.

Numerous small bins (illustrated in Figure 7) are constructed so that they can be handled either by the fork-lift truck or by the cranes. All the material for a specific job which conveniently can be placed therein is put into one of these bins for transport to the job site. These bins are used to hold all the disassembled parts of a pump, turbine, or any other piece of equipment on which work is being done. Other types of bins are used in the welding section; these are designed so that they will sit one on top of the other for the purpose of holding fabrication parts such as flanges, welding ells, tees, and similar. Figure 8 illustrates these bins.

The load luggers used in the refinery are employed for the collection of scrap and waste in the building. Pans are placed in the craft areas where they will be accessible for removal by the truck. The sawdust and shavings from the carpenter-section cyclone collector are deposited in an enclosed-type pan for periodic disposal.

Shop Job Expediter

All of this new equipment, and the money expended for it, will not pro-

Figure 11. Job Control Board.

vide better and lower-cost maintenance unless advantage is taken of the most modern materials-handling methods and shop coordination.

Prior to the completion of our shop, several of our staff personnel visited a number of job shops throughout the country for study and analysis of the scheduling, planning, coordinating, and expediting of these job shops. Many excellent systems were studied, but the majority of them are not suitable for a refinery-maintenance shop, because the time which they allow for the preparatory work incident to the starting of a job usually is longer than an oil refinery can provide for the entire job itself. Furthermore, the success of all these systems depends on the individual who is responsible for their administration or, as he is usually called, the job expediter. What is required is an eager young man with the know-how—and a "burr under his tail." This is what we have tried to obtain—a job expediter who is "short on paper work—long on expediting." His overall responsibilities include:

1. Upon receipt of a job in the shop, he expedites and controls the flow of the job between shop areas. He keeps himself informed at all times as to the status of every job which moves through more than one shop.

2. Upon completion of the work on a job, he arranges for and expedites the movement of the job to the proper field site. Automotive equipment is available to the expediter for the most efficient handling of all materials, as needed.

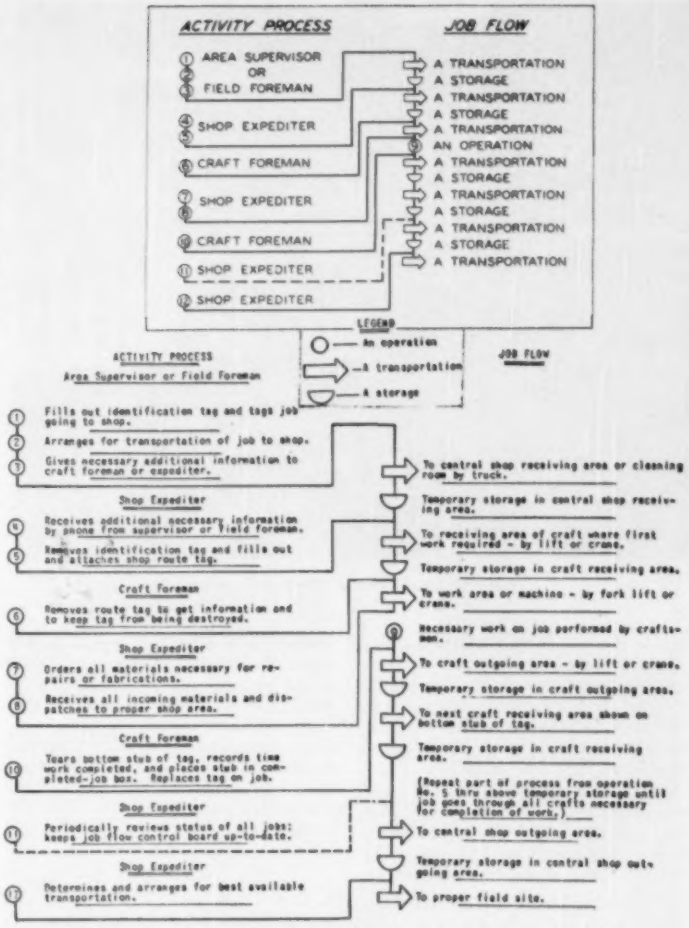
3. He orders necessary materials from the warehouse, and requests their delivery at the proper time.

4. He receives all materials which come into the shop, and he dispatches them to the proper craft areas.

Effective coordination, which is designed to keep the work flowing through the central shop at all times, requires cooperation with the shop expediter of the individual shop foremen, zone supervisors, and field foremen. The shop expediter is notified of all special or unusual requirements which may arise, so that the most efficient control of the work will be had at all times.

General explanations and clarifications are as follows:

1. The identification tags used by field foremen or zone supervisors to tag jobs going to the shop are buff-colored, Figure 9. Upon such a tag is written the job order number; equipment numbers; brief explanation of the work to be performed; sections through which the work must flow—listed in order of necessary sequence of work and priority of the job; and some indication as to where the completed job is to be delivered. This tag is not intended to carry every detail of a specific job. Additional information is given to various shop foremen by phone and, if necessary, it is supplemented by sketches or prints.


ACTIVITY PROCESS
JOB FLOW
1 AREA SUPERVISOR OR 3 FIELD FOREMAN
4 5 SHOP EXPEDITER
6 CRAFT FOREMAN
7 8 SHOP EXPEDITER
10 CRAFT FOREMAN
11 SHOP EXPEDITER
12 SHOP EXPEDITER
A TRANSPORTATION
A STORAGE
A TRANSPORTATION
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A TRANSPORTATION
AN OPERATION
A TRANSPORTATION
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A STORAGE
A TRANSPORTATION
A STORAGE
A TRANSPORTATION
LEGEND
An operation
A transportation
A storage
ACTIVITY PROCESS
JOB FLOW
Area Supervisor or Field Foreman
1 Fills out identification tag and tags job going to shop.
2 Arranges for transportation of job to shop.
3 Gives necessary additional information to craft foreman or expediter.
Shop Expediter
4 Receives additional necessary information by phone from supervisor or field foreman.
5 Removes identification tag and fills out and attaches shop route tag.
Craft Foreman
6 Removes route tag to get information and to keep tag from being destroyed.
Shop Expediter
7 Orders all materials necessary for repairs or fabrications.
8 Receives all incoming materials and dispatches to proper shop area.
Craft Foreman
10 Tears bottom stub of tag, records time work completed, and places stub in completed-job box. Replaces tag on job.
Shop Expediter
11 Periodically reviews status of all jobs; keeps job flow control board up-to-date.
Shop Expediter
12 Determines and arranges for best available transportation.
To central shop receiving area or cleaning room by truck.
Temporary storage in central shop receiving area.
To receiving area of craft where first work required - by lift or crane.
Temporary storage in craft receiving area.
To work area or machine - by fork lift or crane.
9 Necessary work on job performed by craftsman.
To craft outgoing area - by lift or crane.
Temporary storage in craft outgoing area.
To next craft receiving area shown on bottom stub of tag.
Temporary storage in craft receiving area.
(Repeat part of process from operation No. 5 thru above temporary storage until job goes through all crafts necessary for completion of work.)
To central shop outgoing area.
Temporary storage in central shop outgoing area.
To proper field site.

Figure 12. Flow Diagram of Work Movement through the Shell Shop at Houston.

2. The shop route tags, Figure 10, are filled in by the shop expediter as soon as he receives the job from the field, or when he receives by phone additional required information from field foremen or zone supervisors. Jobs are divided into No. 1, 2, and 3 priority—identified, respectively, by red, yellow, and green tags. Normally, No. 1 priority is considered an emergency, and it is used only when there is an actual emergency. No. 2 priority is considered urgent, and it includes normal shutdown jobs or jobs which have a time limit. No. 3 priority is considered routine, and it is confined to routine jobs.

This establishment of priority is handled as conscientiously as possible, and with the utmost cooperation of field foremen and supervisors with the expediter.

3. The shop route tags carry three stubs, which are filled in by the expediter; they show the expected route of a specific job. The outside stub designates the section where work on the job will be performed first; the middle stub designates the section where the next work is to be performed; and the inside stub designates the third section where work will be performed.

If work on a job is to be completed in less than three sections, unused stubs are left blank. If more than three sections are to work on a job, two tags should be used—with the second tag showing fourth, fifth, and sixth sections. Upon completion of a job in one of these sections, a craft foreman re-

Figure 13. Interior View of Shop from South End.

moves the stub which designates this worker's craft, and he records the time of completion. This stub is retained by the craft section, and it is accessible in the event the expediter should desire to review all stubs. Thus at any time he may know the status of all jobs.

The expediter also maintains a job control board, which shows the location and the status of all jobs which flow between individual sections. The control board is shown in Figure 11.

4. If for any reason it becomes necessary for a job to be moved between craft sections contrary to the route shown on the tag, the craft foreman notifies the expediter so that a new tag may be made up and the expediter's record of route can be revised. If unexpected work arises which requires routing of the job to additional sections, any blank stubs left on the tag are filled in by the craft foreman who handles the job, and he then notifies the expediter of such additions.

If work is to be done on more than one unit of equipment under a single job order number, each unit carries a separate tag; and the job order number is followed by the letters "A," "B," etc., to identify each separate unit. If equipment is broken down into several different units after it has entered the first section, the exepditer is notified so that he can properly tag each unit and revise his job and route record.

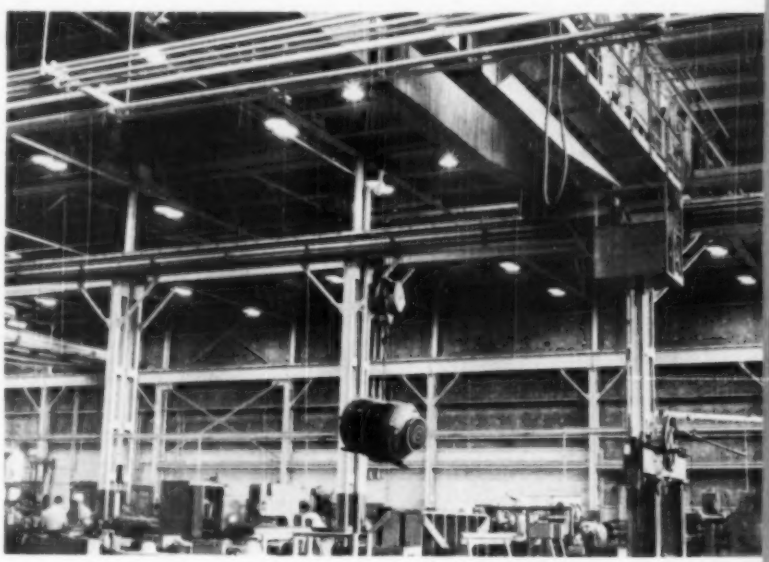
5. A central-shop receiving and dispatching area is designated in a central location. Each craft section has similar receiving and outgoing areas. It is the responsibility of the various craft foremen to expedite the movement of jobs from the craft receiving area to the work area, and from the work area to the craft outgoing area. It is the responsibility of the expediter to see that these jobs move quickly, and in the most efficient manner, from the craft areas, as well as from the central shop, to the proper field sites. Figure 12 is a flow diagram of the movement of work through the shop.

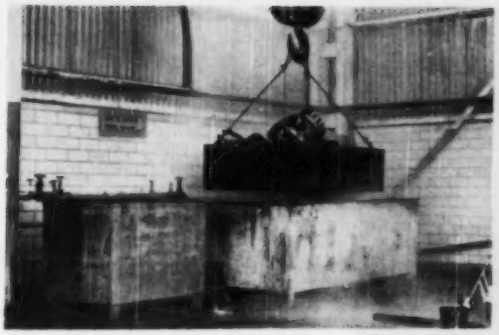
General Purpose and Manning of the Shop

It should be clearly understood that we are here concerned with a maintenance shop—not a fabrication shop. The primary purpose of the construction of this unit was to increase maintenance efficiency through decreased cost. This is not to say that no fabrication work will be done. The manpower requirements of a refinery of this size are based on the personnel needed to handle the major plant turnarounds. Usually one of these turnarounds occurs each week so that, in general, maintenance forces are continuously occupied. However, there are slack periods when some of the members of the various crafts are not fully occupied. It is for these slack periods that a certain amount of fabrication work is planned.

We recognize that we are not set up for production-line fabrication, although we can closely approximate it; and many articles can be fabricated on a competitive basis. However, such fabrication results in a saving of out-of-pocket expense to the company, because the labor expended may be considered an overhead item. Even if the labor and material expended were greater than the cost of a purchased item, there would still be a saving if we did the fabrication by making use of this overhead labor. However, when we hire personnel for the purpose of

Figure 14. One of the Bridge Cranes.





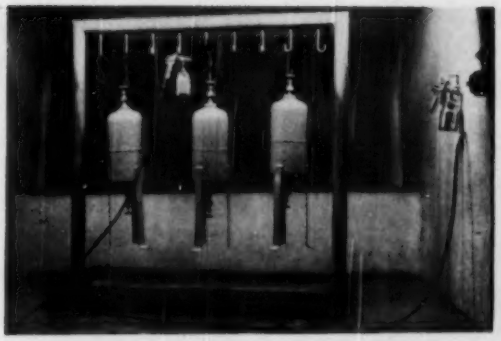
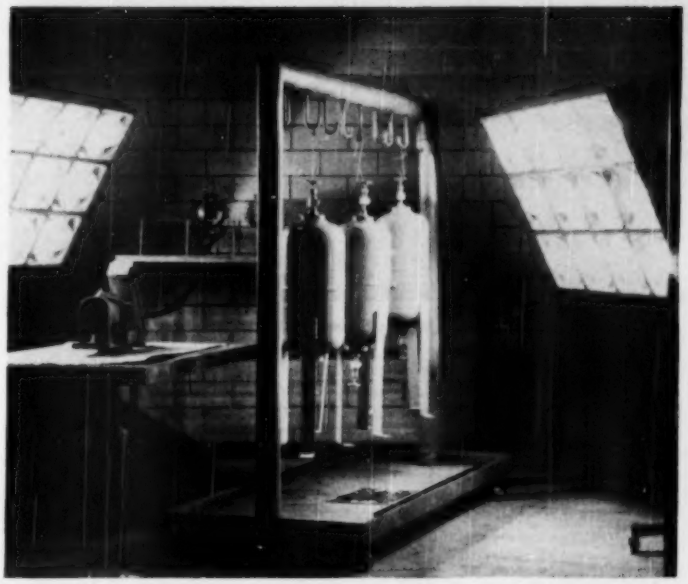


Figure 15 (above). Basketful of Fittings Going into Bath for Cleaning.

Figure 16 (above right). Water Paint-Spray Booth.

Figure 17 (right). Paint-Drying Room.



fabrication, we are out of the oil business and are in the machine-shop business—and this, of course, is not our purpose.

Regardless of the magnitude of the shop, or of the attractiveness of its interior and its modern equipment, only the manpower to operate it effectively is of any real consequence. Well-trained skilled craftsmen are essential. Our craftsmen, for the most part, are trained in our own plant through on-the-job upgrade training. Each man, as he steps up in classification from helper to first-class mechanic, must meet specific and established qualifications. He is given adequate opportunity to become qualified through a diversity of job assignments. A certain amount of preparatory academic work is given, on company time, to prepare helpers for the work training. By these means we have been quite successful in obtaining qualified craftsmen.

It is difficult to evaluate, in terms of dollars and cents, the actual returns of an installation of this type. Of course, there is one way of evaluating it: If tools are used in the most efficient and effective manner, the number of men required to do the work is reduced; thus a decrease in payroll should result. Furthermore, modern shop equipment makes possible quality and precision work, so that failures should occur less frequently. This also may be reflected in reduced manpower. However, the real payout on a project of this sort lies in getting back into operation those units which are out of service for maintenance—thus considerably reducing downtime.

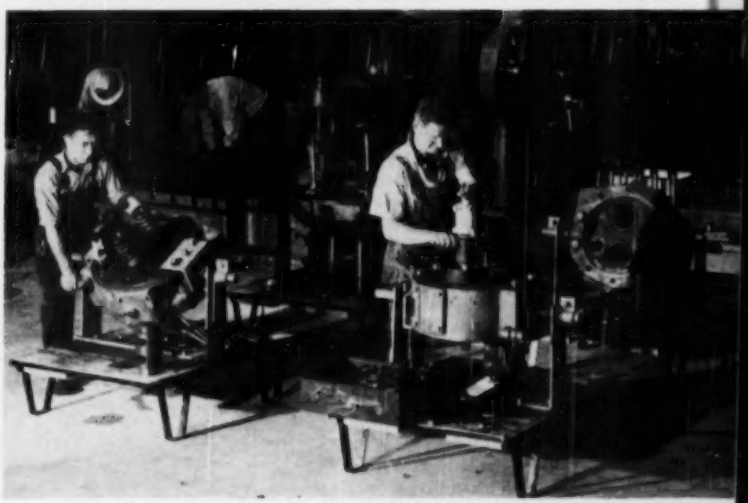


Figure 18. Machine-Shop Assembly Section—Special Jigs for Handling Compressor Valves.

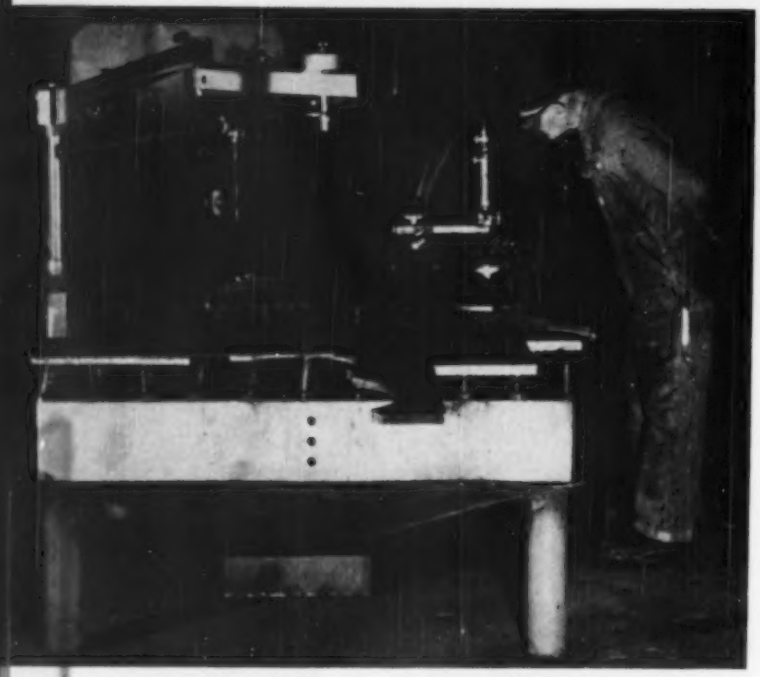


Figure 19. Automatic Burning Equipment—Special Stud-Type Table.

List of Machine Tools

Instrument section: 1, gage test bench; 2, water-column calibrators; 2, 3⅜-in. x 3⅛-in. x 1¾-in. x ¾-in. x 2¾-in. compressors; 1, hydraulic pump; 1, 10-in. pedestal grinder; 1, high-pressure test bench; 1 ⅜-in. bench drill press; 1, 6-in. jeweler's lathe; 2, micro engravers; and 1, 12-in. band saw (bench-type).

Tool room: 1, 10-in. carbide tool grinder; 1, 6-in. tool and cutter grinder; 2, 10-in. pedestal grinders; 1, 8-in. Universal tool grinder; 1, 14-in. x 54-in. tool-room lathe; 1, ⅜-in. bench drill press; 1, 16-in. table drill press.

Carpenter section: 1, saw filer; 1, 10-in. pedestal grinder; 1, 16-in. table drill press; 1, wetstone grinder; 1, cyclone dust and shaving collector; 1, mortiser machine; 1, 6-in. jointer; 2, 16-in. circular saws (table-type); 1, 12-in. jointer; 1, 30-in. x 15-in. band saw; 1, 18-in. x 6-in. band saw; 1, 16-in. circular saw (pedestal-type, DeWalt); 1, belt sander; 1, 24-in. planer.

Valve section: 1, 20-in. table drill press; 1, 30-in. table drill press; 1, 10-in. buffer and sander.

Blacksmith section: 1, 14-in. pedestal grinder; 1, 20-in. x 72-in. 2000-degree hardening furnace; 1, 60-in. x 72-in. 1250-degree cyclone annealing furnace; 1, 12-in. x 24-in. x 10-in. 2250-degree Globar hardening furnace; 1, 24-in. x 36-in. x 18-in. 1850-degree electric furnace; 2, forges; 2, anvils; 2, 500-lb. steam hammers; 1, quench vat (oil); 1, quench vat (water); 1, water cooler and pump; 1, brine-circulating pump; 1, oil-circulating pump; 1, hot flange table; 1, inert-gas generator; 1, hardness tester.

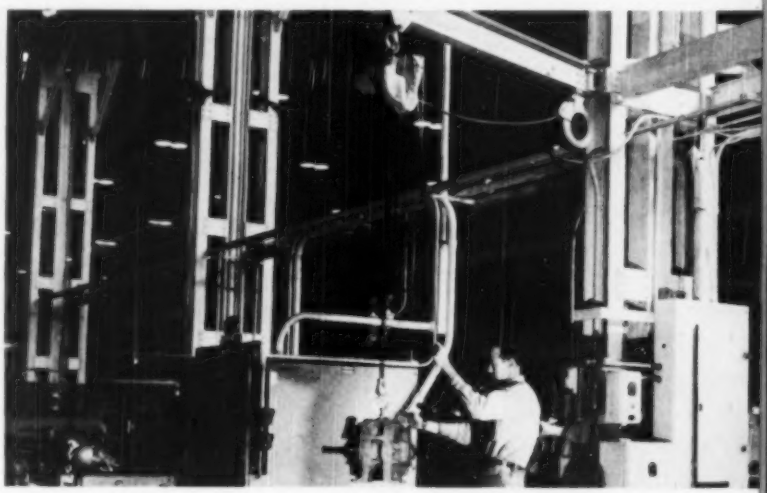
Welding section: 2, welding positioners; 1, 14-in. pedestal grinder; 1, submerge arc welder with positioner rolls; 12, electric arc-welding machines; 1, circular acetylene cutting machine; 1, straight acetylene cutting machine.

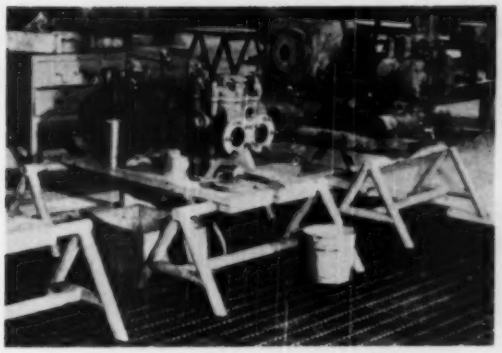
Pipe section: 1, 6-in. pipe-bending machine; 1, 10-in. pedestal grinder; 1, gasket cutter; 1, 12-in. power hack saw; 1, ¼-in. x 2-in. bolt-threading machine; 2, ¼-in. x 2-in. pipe-threading machines; 1, 2½-in. x 8-in. pipe threading machine; 1, 8-in. abrasive saw; 1, 6-in. bench grinder; 1, steam trap testing bench.

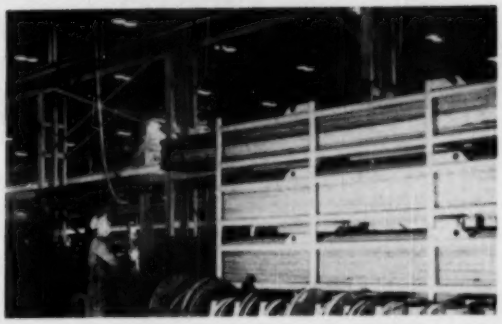
Boiler section: 1, 6-in. abrasive tube cutoff saw; 1, 8-in. abrasive saw; 1, ⅜-in. x 2½-in. horizontal angle roll; 1, 21-in. table drill press; 1, ¾-in. x 8-ft. plate roll; 1, ¼-in. x 6-ft. slip roll; 2, 14-in. pedestal grinders; 1, ¼-in. x 10-ft. press brake; 1, ⅝-in. punch and shear; 1, ½-in. x 12-ft. square shear; 1, ⅜-in. rotary shear; 1, 1000-lb. hydraulic test pump.

Machine section: 3, 14-in. x 54-in. lathes; 1, 14-in. x 78-in. lathe; 5, 16-in. x 78-in. lathes; 2, 20-in. x 96-in. lathes; 1, 30-in. x 168-in. lathe; 5, 14-in. pedestal grinders; 2, 10-in. pedestal grinders; 1, 900-lb. Dynetric balancer; 1, 1800-lb. Dynetric balancer; 1, static balancer; 1, 21-in. table drill press; 1, 4-ft. radial drill press; 1, 3½-ft. radial drill press; 1, 2-ft. radial drill press; 1, 6-ft. radial drill press; 1, 6-in. key seater; 1, 12-in. abrasive saw; 1, 14-in. power hack saw; 1, 300-ton horizontal hydraulic press; 1, 60-ton vertical hydraulic press; 1, 25-ton vertical hydraulic press; 1, 36-in. metal band saw; 1, No. 2 Universal milling machine; 1, No. 3 Universal milling ma-

Figure 20. A Jib Crane in Use.







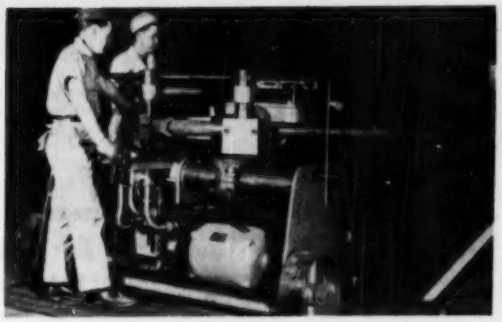


Figure 21 (immediately above). Pump-Disassembly Section—Pit for Catching Pump Drainings in Shell Refinery Shop, Houston.

Figure 22 (above at right). Storage Racks for Heat-Exchanger Tubes, Baffles, and Tube Sheets.

Figure 23 (at right). Hydraulic Pipe-Bending Machine in Use at Shell Oil Company's Houston Refinery.

chine; 1, No. 5 Universal milling machine; 1, 56-in. horizontal boring mill; 1, 20-in. shaper; 2, $\frac{3}{8}$-in. bench drill presses; 1, 64-in. vertical boring machine; 1, 16-in. x 120-in. cylindrical grinder; 1, centrifugal babbit-bearing machine; 1, babbitt furnace; 1, 6-in. carbide tool grinder.

Tin section: 1, electric spot welder; 1, edge roll; 1, 4-in. locking roll; 1, combination crimp and flaring roll; 1, 42-in. x 20-gage folder; 1, 120-in. x 14-gage box-and-pan brake; 1, 48-in. circular shear; 1, 36-in. square shear; 1, 3-in. x 36-in. roll; 1, 96-in. x 16-gage brake; 1, 10-in. pedestal grinder; 1, inert electric arc welder.

Electric section: 1, 16-in. table drill press; 1, 10-in. pedestal grinder; 1, 8-ft. x 6-ft. x 8-ft. 350-degree drying oven; 1, 110- to 220-volt motor-generator test block; 1, 440-volt motor-generator test block; 1, 2300-volt motor-generator test block.

Paint section: 1, 8-ft. paint-spray booth with water-wash filter; 2, sets of 20 lamps (each infra-ray drying lamps).

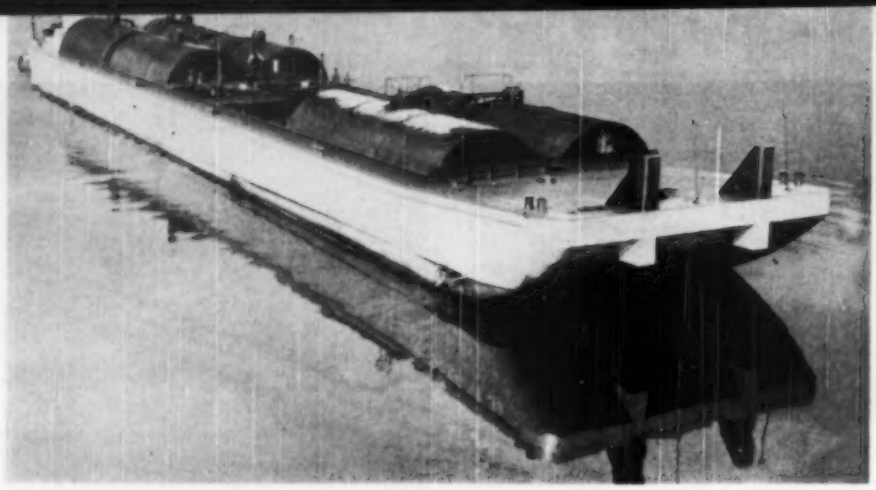
Insulator section: 1, 36-in. x 18-in. band saw.

Rigger section: 1, 8-in. pedestal grinder; 1, $\frac{3}{4}$-in. wire-rope splicing vise.

All sections: 1, 15-ton, overhead crane; 1, 10-ton overhead crane; 1, 5-ton overhead crane; 6, 30-ft. wall jib cranes with 2000-lb. electric hoists; 6, 20-ft. wall jib cranes with 2000-lb. electric hoists.

Cleaning building: 1, 11-ft. x 15-ft. sandblasting room with grit cleaner and filter; 1, 3-ft. x 6-ft. cleaning vat (steam-coil); 1, 4-ft. x 8-ft. cleaning vat (steam-coil); 1, 5-ft. x 16-ft. tube-bundle cleaning vat with 650-pound pressure pump for spray nozzles (steam-coil); 1, 15-ton overhead crane; 1, 3-ft. x 3-ft. x 8-ft. 6-compartment tank for cleaning fluids; 6, 120-gal. oil lubsters; 2, 60-gal. oil lubsters.

Figure 24. Pipe-Cutting and Threading Section in Shop, Shell's Houston Refinery.



New "Thermos Jug" Barge Designed for Transporting Lube Oil Stocks at High Temperature from Houston to a Mississippi River Terminal 9 Miles Above New Orleans.

"Thermos Jug" Tanks For Lube Stocks Now in Service

TANKS insulated to prevent temperature of lube oil stocks from dropping more than 20° F. during six days at 32° F. outside temperature are used on a new river barge built by Dravo Corporation for Intercoastal canal operation by Lake Tankers Corporation between Houston and New Orleans.

The tanks are cradled side by side longitudinally in wood blocking fitted on steel saddles. Each tank is covered with a two-inch layer of glass fiber insulation held by welded steel clips, band iron and expanded metal lath. A film of vinyl resin is sprayed on the metal lath, followed by a coat of vapor sealing material, a layer of cotton scrim and a final coat of vapor sealing material.

Lube oil—either bright or neutral stock—is loaded at a temperature between 110° and 140° F. Based on outside temperature range and the length of the trip, the cargo will be discharged at 90° F. or more, the minimum temperature for unloading stock. With equipment previously used, the oil temperature sometimes dropped to 65° F.

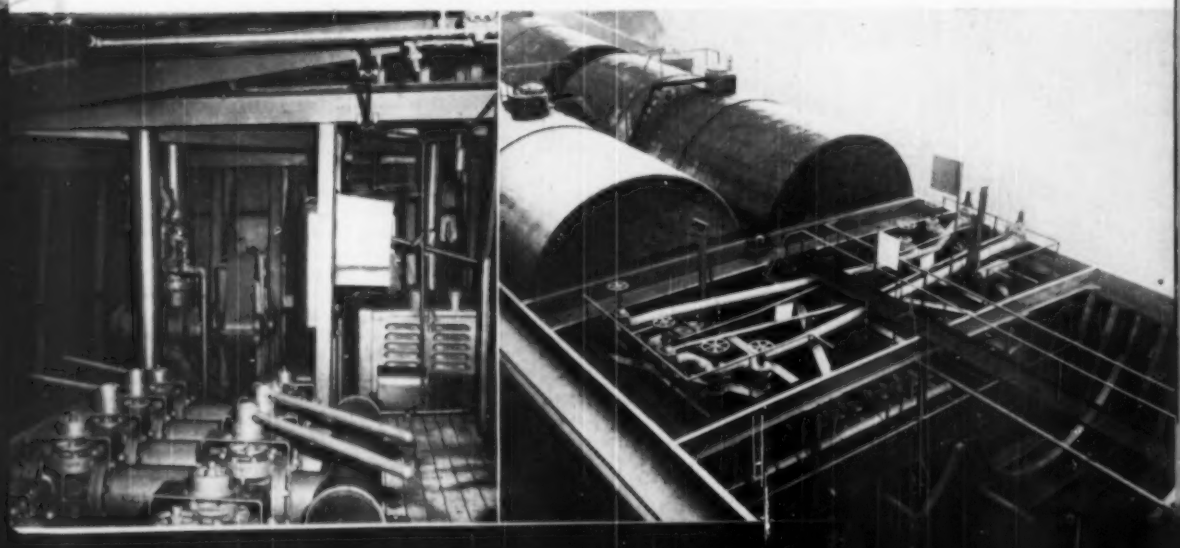
As an added precaution, the tanks are equipped with steam coils which can be supplied with shore steam through a 3-inch header down the centerline of the barge.

The cargo piping arrangement and pumping machinery enables discharge of two different cargoes simultaneously without contamination. Moreover, the use of valves controlled by key wrenches prevents accidental contamination of cargo in the manifold piping. The machinery compartment is located approximately in the center of the barge.

The cargo pumps are driven by two diesel engines modified to meet the unusual service conditions. To permit the safe transportation of gasoline and other Grade B cargoes, all engine electrical accessories have been eliminated. In place of starting batteries, an air motor system is employed. Other modifications to the cargo pump engines include a hydraulic governor set at 1750 rpm. with maximum setting for intermittent overload to 145 hp., and installation of various power take-offs.

Each suction line and each discharge header has a 2-inch stripping pipe connected to its lowest point, and controlled by a globe valve operated from the floor plating in the machinery compartment.

The barge is 240 feet long, 40 feet wide and 12 feet deep. The rake radius is 40 feet. Two towing "knees" are installed on each end of the barge for flexibility in operation.



Left—Part of Machinery Compartment Showing Double Manifold in Foreground with its Key-Wrench Valve Control Arrangement that Prevents Accidental Contamination of Cargo.

Right—Machinery Compartment in Center of the Barge with Cargo Loading and Discharge Lines Above. Empty Cradles Are for Future Installation of Two Additional Tanks.

THERMOCHEMISTRY for the Petrochemical Industry

Part XI—Cyanogen Compounds

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Department of Chemical Engineering
University of Texas, Austin

THIS DISCUSSION, which presents the thermodynamic data for the cyanogen compounds, includes the sixty-first compound in this series. Previous articles have dealt with hydrocarbon compounds,[8, 9, 10, 11, 12] combustion gases,[13] sulfur compounds,[14] halogen compounds[15] and chlorinated methanes.[16] This paper treats cyanogen, $(CN)_2$; hydrogen cyanide, HCN; cyanogen chloride, CNCl; cyanogen bromide, CNBr; cyanogen iodide, CNI; methyl cyanide, CH_3CN; and acrylonitrile, $CH_2=CHCN$.

Dr. Kobe is a professor of chemical engineering at the University of Texas and Mr. Long, formerly a Celanese fellow at Austin, is now connected with Johns-Manville.

TABLE 1 summarizes the heat capacity determinations of cyanogen compounds. In each case, the worker or workers tabulated last, have been the chief source of the data presented here. It is noted that this group of compounds has not been the subject of extensive work.

TABLE 1
Reported Heat Capacity Data for Cyanogen Compounds

Compound	Temperature Range	Method	Workers	Reference
Cyanogen $(CN)_2$	273 to 327° K.	Calorimetric	Bruick and Yost	2
	185 to 320° K.	Calorimetric	Stitt	20
	250 to 500° K.	Spectroscopic	Stevenson	19
	291 to 1000° K.	Spectroscopic	Thompson	21
Hydrogen Cyanide (HCN)	17 to 210° C.	Velocity of Sound	Bredig and Teichman	1
	30 to 148° C.	Calorimetric	Felsing and Drake	4
	298 to 1500° K.	Spectroscopic	Kelly	6
Cyanogen Chloride (CNCl)	250 to 500° K.	Spectroscopic	Stevenson	19
	600 to 1000° K.	Spectroscopic	Spencer	18
Cyanogen Bromide (CNBr)	250 to 500° K.	Spectroscopic	Stevenson	19
	600 to 1000° K.	Spectroscopic	Spencer	18
Cyanogen Iodide (CNI)	250 to 500° K.	Spectroscopic	Stevenson	19
	600 to 1000° K.	Spectroscopic	Spencer	18
Methyl Cyanide (CH_3CN)	0 to 300° C.	Spectroscopic	Ewell and Bourland	3
	291 to 1200° K.	Spectroscopic	Thompson	21
Acrylonitrile ($CH_2=CHCN$)	298 to 1000° K	Spectroscopic	Halverson, Stamm and Whalen	5

TABLE 2
Free Energies of Formation, Heats of Formation and Heats of of Combustion of the Cyanogen Compounds at 25° C.[1]

Compound	Molecular Weight	$\Delta G_f°$ cal./g-mole	$\Delta H_f°$ cal./g-mole	$-\Delta H°_c$, cal./g-mole[2] $CO_2(g)$, $H_2O(g)$, $N_2(g)$, $HX(g)$
HCN	27.026	28,700	31,200	154,200
CNCl	61.475	32,900	34,500	150,600
CNBr	105.934	.....	.....	.....
CNI	152.94	47,700	54,600	142,500
$(CN)_2$	52.036	70,810	73,600	261,700
CH_3CN	41.051	.....	.....	.....
$CH_2=CHCN$	53.061	.....	.....	.....

[1] $-\Delta H_c°$ represents the heat evolved at 25° C. and constant pressure in the combustion of the gaseous compounds in the gaseous oxygen (and, or hydrogen) to form the products indicated with all the reactants and products in their appropriate standard reference states.

$\Delta H_f°$ and $\Delta G_f°$ represent the changes in the heat content (enthalpy) and free energy, respectively, for the formation of the gaseous compounds from the elements, with all the reactants and products in their appropriate standard reference states.

[2] The heat of solution of gaseous HCl in dilute aqueous solution is −17,960 cal./g-mole, of gaseous HBr is −20,240 cal./g-mole and of gaseous HI is −19,520 cal./g-mole. The latent heat of vaporization of water is 10,519 cal./g-mole.

TABLE 3
Heat Capacities of Cyanogen Compounds
cal./g-mole • °C.

°C.	$(CN)_2$	HCN	CNCl	CNBr	CNI	CH_3CN	$CH_2=CHCN$
0	13.27	8.33	10.41	10.89	11.34	11.92	14.40
18	13.50	8.53	10.62	11.05	11.50	12.39	15.00
25	13.60	8.59	10.69	11.12	11.55	12.49	15.24
100	14.52	9.21	11.35	11.70	12.02	14.13	17.56
200	15.44	9.86	11.94	12.21	12.44	16.20	20.28
300	16.17	10.38	12.38	12.60	12.77	18.02	22.54
400	16.76	10.84	12.75	12.91	13.04	19.61	24.44
500	17.30	11.24	13.05	13.18	13.28	20.99	26.01
600	17.76	11.61	13.30	13.42	13.50	22.19	27.39
700	18.14	11.92	13.51	13.61	13.68	23.30	28.57
800	.....	12.21	.....	.....	.....	24.27	.....
900	.....	12.47	.....	.....	.....	25.05	.....
1000	.....	12.70	.....	.....	.....	.....	.....
1100	.....	12.92	.....	.....	.....	.....	.....
1200	.....	13.11	.....	.....	.....	.....	.....

TABLE 4
Heat Capacities of Cyanogen Compounds
cal./g-mole • °K.

°K.	$(CN)_2$	HCN	CNCl	CNBr	CNI	CH_3CN	$CH_2=CHCN$
273	13.27	8.33	10.41	10.89	11.34	11.92	14.40
291	13.50	8.53	10.62	11.05	11.50	12.39	15.00
298	13.60	8.59	10.69	11.12	11.55	12.49	15.24
300	13.63	8.60	10.72	11.14	11.57	12.53	15.30
400	14.80	9.40	11.54	11.85	12.15	14.70	18.36
500	15.65	10.00	12.07	12.32	12.54	16.71	20.95
600	16.33	10.51	12.48	12.68	12.85	18.47	23.11
700	16.91	10.95	12.83	12.98	13.11	20.00	24.90
800	17.43	11.34	13.12	13.24	13.34	21.33	26.43
900	17.87	11.69	13.36	13.46	13.55	22.50	27.75
1000	18.25	12.00	13.56	13.64	13.72	23.58	28.88
1100	.....	12.28	.....	.....	.....	24.50	.....
1200	.....	12.54	.....	.....	.....	25.22	.....
1300	.....	12.76	.....	.....	.....	.....	.....
1400	.....	12.97	.....	.....	.....	.....	.....
1500	.....	13.15	.....	.....	.....	.....	.....

TABLE 5
Heat Capacities of Cyanogen Compounds
Btu./lb.-mole • °F.

°F.	$(CN)_2$	HCN	CNCl	CNBr	CNI	CH_3CN	$CH_2=CHCN$
32	13.27	8.33	10.41	10.89	11.34	11.92	14.40
60	13.48	8.49	10.59	11.04	11.48	12.28	14.90
77	13.60	8.59	10.69	11.12	11.55	12.49	15.24
100	13.77	8.70	10.83	11.25	11.65	12.78	15.62
200	14.45	9.16	11.30	11.66	11.99	13.99	17.35
300	15.00	9.55	11.67	11.97	12.25	15.18	18.94
400	15.47	9.88	11.96	12.23	12.47	16.29	20.39
500	15.88	10.18	12.21	12.45	12.65	17.32	21.69
600	16.27	10.45	12.44	12.65	12.82	18.28	22.86
700	16.59	10.71	12.65	12.82	12.97	19.18	23.91
800	16.91	10.95	12.83	12.98	13.11	20.00	24.90
900	17.21	11.18	13.00	13.13	13.24	20.76	25.76
1000	17.48	11.38	13.14	13.27	13.36	21.46	26.57
1100	17.73	11.58	13.28	13.41	13.48	22.12	27.30
1200	17.95	11.76	13.40	13.52	13.59	22.75	27.99
1300	18.15	11.93	13.52	13.62	13.68	23.35	28.62
1400	.....	12.09	.....	.....	.....	23.91	.....
1500	.....	12.25	.....	.....	.....	24.41	.....
1600	.....	12.40	.....	.....	.....	24.84	.....
1700	.....	12.54	.....	.....	.....	25.22	.....
1800	.....	12.66	.....	.....	.....	.....	.....
1900	.....	12.78	.....	.....	.....	.....	.....
2000	.....	12.90	.....	.....	.....	.....	.....
2100	.....	13.02	.....	.....	.....	.....	.....
2200	.....	13.12	.....	.....	.....	.....	.....

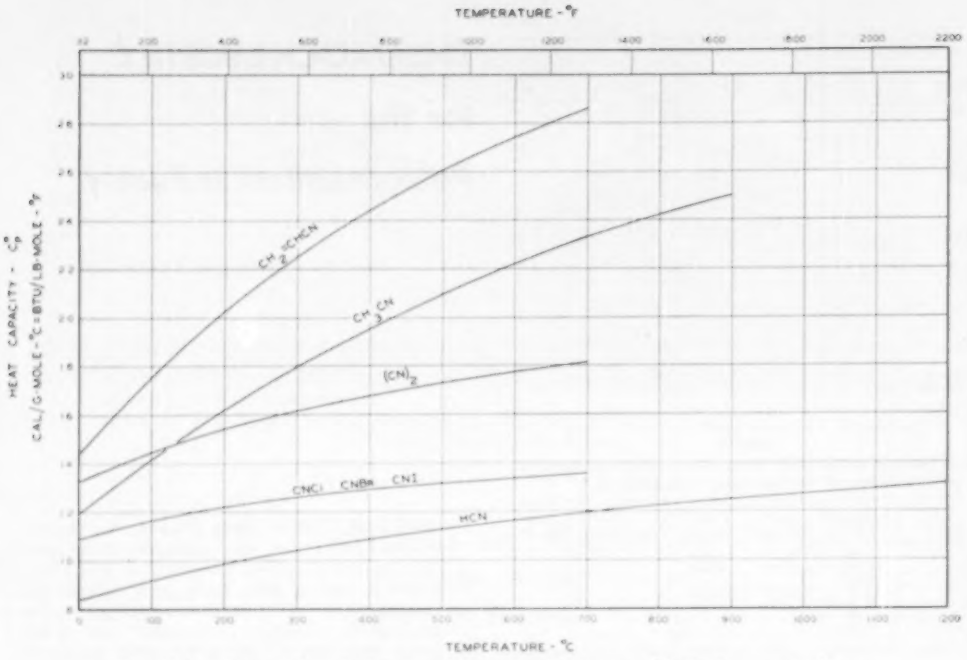

Figure 1. Heat Capacity Curves for Cyanogen, Hydrogen Cyanide, Cyanogen Chloride, Cyanogen Bromide, Cyanogen Iodide, Methyl Cyanide and Acrylonitrile.

TABLE 6

Heat Capacities of Cyanogen Compounds
Btu./lb.-mole · °R.

°R.	$(CN)_2$	HCN	CNCl	CNBr	CNI	CH_3CN	CH_2=CHCN
492	13.27	8.83	10.41	10.89	11.34	11.92	14.40
500	13.33	8.38	10.46	10.92	11.39	12.02	14.55
520	13.48	8.49	10.59	11.04	11.48	12.28	14.90
537	13.60	8.59	10.69	11.12	11.55	12.49	15.24
600	14.08	8.89	11.03	11.43	11.81	13.27	16.34
700	14.68	9.32	11.46	11.80	12.10	14.47	18.00
800	15.19	9.69	11.79	12.08	12.34	15.64	19.53
900	15.64	10.00	12.07	12.32	12.54	16.71	20.94
1000	16.03	10.29	12.30	12.54	12.72	17.72	22.17
1100	16.40	10.56	12.53	12.72	12.88	18.65	23.29
1200	16.72	10.81	12.73	12.89	13.03	19.51	24.30
1300	17.03	11.04	12.90	13.04	13.16	20.31	25.25
1400	17.32	11.26	13.06	13.19	13.30	21.04	26.09
1500	17.58	11.46	13.21	13.33	13.42	21.73	26.85
1600	17.82	11.66	13.33	13.44	13.53	22.37	27.57
1700	18.03	11.83	13.44	13.54	13.63	23.00	28.23
1800	18.23	12.00	13.56	13.64	13.72	23.58	28.88
1900	.....	12.16	.....	.....	.....	24.11	.....
2000	.....	12.31	.....	.....	.....	24.59	.....
2100	.....	12.45	.....	.....	.....	25.00	.....
2200	.....	12.59	.....	.....	.....	25.35	.....
2300	.....	12.71	.....	.....	.....	.....	.....
2400	.....	12.83	.....	.....	.....	.....	.....
2500	.....	12.95	.....	.....	.....	.....	.....
2600	.....	13.06	.....	.....	.....	.....	.....

TABLE 7

Enthalpies of Cyanogen Compounds
cal./g-mole

°C.	$(CN)_2$	HCN	CNCl	CNBr	CNI	CH_3CN	CH_2=CHCN
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	241.4	151.7	189.2	197.5	205.5	219.1	264.3
25	336.3	211.8	263.8	275.3	286.2	306.1	369.8
100	1391.	883.5	1094.	1133.	1161.	1305.	1597.
200	2892.	1857.	2290.	2330.	2395.	2829.	3512.
300	4475.	2850.	3476.	3571.	3657.	4542.	5646.
400	6123.	3912.	4733.	4847.	4947.	6426.	8003.
500	7827.	5018.	6023.	6152.	6264.	8458.	10526.
600	9580.	6162.	7340.	7482.	7603.	10620.	13210.
700	11380.	7339.	8680.	8834.	8962.	12890.	16000.
800	.....	8547.	.....	.....	.....	15280.	.....
900	.....	9783.	.....	.....	.....	17740.	.....
1000	.....	11043.	.....	.....	.....	.....	.....
1100	.....	12320.	.....	.....	.....	.....	.....
1200	.....	13620.	.....	.....	.....	.....	.....

TABLE 8

Enthalpies of Cyanogen Compounds
cal./g-mole

°K.	$(CN)_2$	HCN	CNCl	CNBr	CNI	CH_3CN	CH_2=CHCN
273	0.0	0.0	0.0	0.0	0.0	0.0	0.0
291	241.4	148.9	189.2	196.9	205.5	219.1	264.3
298	336.3	211.7	263.8	274.0	286.2	306.1	369.8
300	363.5	228.9	283.2	296.3	309.3	331.2	400.3
400	1779.	1134.	1401.	1457.	1497.	1694.	2094.
500	3304.	2106.	2583.	2662.	2732.	3268.	4061.
600	4963.	3132.	3811.	3913.	4002.	5029.	6265.
700	6565.	4206.	5077.	5197.	5300.	6954.	8665.
800	8283.	5322.	6375.	6509.	6623.	9022.	11230.
900	10050.	6475.	7699.	7845.	7968.	11210.	13940.
1000	11860.	7660.	9045.	9201.	9332.	13520.	16770.
1100	.....	8874.	.....	.....	.....	15930.	.....
1200	.....	10116.	.....	.....	.....	18390.	.....
1300	.....	11380.	.....	.....	.....	.....	.....
1400	.....	12670.	.....	.....	.....	.....	.....
1500	.....	13980.	.....	.....	.....	.....	.....

Table 2 has been taken chiefly from the National Bureau of Standards' *Tables of Selected Values of Chemical Thermodynamic properties.*[17] This table records the free energies of formation, heats of formation, and the heats of combustion to form the products indicated in the last column.

Tables 3, 4, 5 and 6 present the ideal molar heat capacities on the four temperature scales. This presentation is also made graphically in Fgure 1.

The ideal molar enthalpies, relative to 0° C. = 32° F., are tabulated in Tables 7, 8, 9 and 10. The enthalpy equivalents, calculated as mean molar heat capacities, are given by Tables 11 and 12 for the Centigrade and Fahrenheit temperature scales respectively. A graphical plot of the

TABLE 9

Enthalpies of Cyanogen Compounds
Btu./lb.-mole

°F.	$(CN)_2$	HCN	CNCl	CNBr	CNI	CH_3CN	$CH_2=CHCN$
32	0.0	0.0	0.0	.00	0.0	0.0	0.0
60	375.2	235.7	294.0	307.2	319.5	339.0	410.2
77	605.3	381.0	474.8	495.5	515.1	551.1	665.6
100	919.4	580.0	728.9	750.6	781.7	841.8	1019.
200	2330.	1480.	1836.	1897.	1994.	2181.	2648.
300	3803.	2413.	2986.	3075.	3176.	3640.	4508.
400	5328.	3383.	4166.	4286.	4412.	5222.	6488.
500	6895.	4384.	5377.	5518.	5668.	6903.	8574.
600	8503.	5414.	6610.	6771.	6964.	8684.	10803.
700	10150.	6476.	7864.	8050.	8229.	10558.	13150.
800	11820.	7563.	9138.	9340.	9533.	12520.	15590.
900	13530.	8670.	10430.	10647.	10852.	14560.	18120.
1000	15270.	9797.	11740.	11970.	12180.	16670.	20710.
1100	17020.	10943.	13060.	13300.	13520.	18830.	23420.
1200	18810.	12110.	14390.	14650.	14880.	21090.	26190.
1300	20610.	13290.	15740.	16010.	16240.	23400.	29020.
1400	.....	14500.	.....	.....	.....	25760.	.....
1500	.....	15710.	.....	.....	.....	28180.	.....
1600	.....	16950.	.....	.....	.....	30640.	.....
1700	.....	18190.	.....	.....	.....	33100.	.....
1800	.....	19450.	.....	.....	.....	.....	.....
1900	.....	20720.	.....	.....	.....	.....	.....
2000	.....	22000.	.....	.....	.....	.....	.....
2100	.....	23300.	.....	.....	.....	.....	.....
2200	.....	24600.	.....	.....	.....	.....	.....

TABLE 10

Enthalpies of Cyanogen Compounds
Btu./lb.-mole

°K.	$(CN)_2$	HCN	CNCl	CNBr	CNI	CH_3CN	$CH_2=CHCN$
492	0.0	0.0	0.0	0.0	0.0	0.0	0.0
500	107.0	66.88	87.79	87.24	90.92	95.76	115.8
520	375.2	235.7	300.3	304.8	319.5	339.0	410.2
537	605.3	381.0	474.8	493.2	515.1	551.1	665.6
600	1476.	932.0	1166.	1203.	1250.	1363.	1652.
700	2874.	1842.	2292.	2365.	2446.	2758.	3343.
800	4369.	2796.	3455.	3560.	3668.	4265.	5277.
900	5910.	3786.	4649.	4780.	4911.	5882.	7301.
1000	7494.	4804.	5868.	6023.	6175.	7605.	9448.
1100	9117.	5848.	7109.	7286.	7454.	9423.	11730.
1200	10770.	6916.	8372.	8567.	8758.	11330.	14110.
1300	12460.	8008.	9653.	9864.	10058.	13320.	16580.
1400	14180.	9124.	10950.	11176.	11380.	15390.	19150.
1500	15920.	10263.	12260.	12500.	12720.	17530.	21800.
1600	17690.	11920.	13590.	13840.	14060.	19740.	24510.
1700	19480.	12900.	14930.	15190.	15420.	22010.	27310.
1800	21300.	13790.	16280.	16580.	16790.	24340.	30180.
1900	.....	15000.	.....	.....	.....	26720.	.....
2000	.....	16220.	.....	.....	.....	29160.	.....
2100	.....	17460.	.....	.....	.....	31640.	.....
2200	.....	18710.	.....	.....	.....	34110.	.....
2300	.....	19970.	.....	.....	.....	.....	.....
2400	.....	21250.	.....	.....	.....	.....	.....
2500	.....	22540.	.....	.....	.....	.....	.....
2600	.....	23840.	.....	.....	.....	.....	.....

enthalpies is made on a double logarithmic diagram in Figure 2.

Simple quadratic equations have been derived for these compounds. These equations are given in Table 13.

TABLE 11

Mean Heat Capacities of Cyanogen Compounds
cal./g-mole · °C.

°C.	$(CN)_2$	HCN	CNCl	CNBr	CNI	CH_3CN	$CH_2=CHCN$
0	13.27	8.33	10.41	10.89	11.34	11.34	14.40
18	13.41	8.43	10.51	10.97	11.42	12.17	14.68
25	13.45	8.47	10.55	11.01	11.45	12.25	14.79
100	13.92	8.84	10.94	11.33	11.71	13.05	15.97
200	14.46	9.18	11.30	11.65	11.99	14.15	17.56
300	14.92	9.50	11.59	11.90	12.19	15.14	18.82
400	15.31	9.78	11.83	12.12	12.37	16.06	20.01
500	15.65	10.04	12.05	12.30	12.53	16.92	21.05
600	15.97	10.27	12.23	12.47	12.67	17.70	22.01
700	16.25	10.48	12.40	12.62	12.80	18.42	22.86
800	.....	10.69	.....	.....	.....	19.09	.....
900	.....	10.87	.....	.....	.....	19.71	.....
1000	.....	11.04	.....	.....	.....	.....	.....
1100	.....	11.20	.....	.....	.....	.....	.....
1200	.....	11.35	.....	.....	.....	.....	.....

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Figure 2 (below). Relative enthalpies for cyanogen, hydrogen cyanide, cyanogen chloride, cyanogen bromide, cyanogen iodide, methyl cyanide and acrylonitrile. Multiply readings in Pcu/lb.-mole by 1.8 to obtain Btu/lb.-mole.

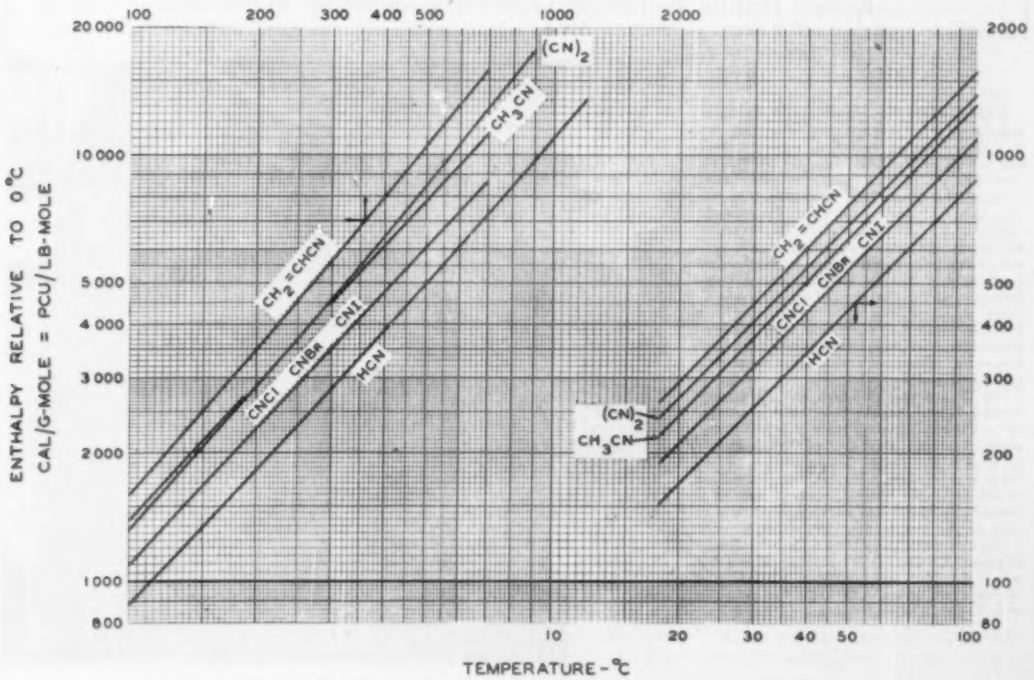

TABLE 12

Mean Heat Capacities of Cyanogen Compounds
Btu./lb.-mole • °F.

°F.	$(CN)_2$	HCN	CNCl	CNBr	CNI	CH_2CN	$CH_2{=}CHCN$
32	13.27	8.33	10.41	10.89	11.34	11.92	14.40
60	13.38	8.42	10.50	10.97	11.41	12.11	14.65
77	13.44	8.47	10.55	11.01	11.45	12.25	14.79
100	13.52	8.53	10.72	11.04	11.50	12.38	14.98
200	13.87	8.81	10.93	11.29	11.69	12.98	15.76
300	14.19	9.00	11.14	11.47	11.85	13.58	16.82
400	14.46	9.19	11.32	11.65	11.99	14.19	17.63
500	14.73	9.37	11.49	11.79	12.11	14.75	18.32
600	14.97	9.54	11.64	11.92	12.22	15.29	19.02
700	15.20	9.70	11.77	12.05	12.32	15.81	19.69
800	15.40	9.85	11.90	12.16	12.41	16.30	20.30
900	15.59	9.99	12.02	12.27	12.50	16.77	20.88
1000	15.77	10.12	12.13	12.36	12.58	17.22	21.40
1100	15.94	10.24	12.23	12.45	12.66	17.65	21.93
1200	16.10	10.37	12.32	12.54	12.74	18.06	22.42
1300	16.25	10.48	12.41	12.62	12.81	18.45	22.89
1400	....	10.59	....	....	....	18.83	....
1500	....	10.71	....	....	....	19.19	....
1600	....	10.81	....	....	....	19.54	....
1700	....	10.90	....	....	....	19.84	....
1800	....	11.00	....	....	....	....	....
1900	....	11.09	....	....	....	....	....
2000	....	11.18	....	....	....	....	....
2100	....	11.27	....	....	....	....	....
2200	....	11.35	....	....	....	....	....

TABLE 13

Heat Capacity Equations of Cyanogen Compounds

Range: 0 to 1200° C. for HCN, 0 to 900° C. for CH_2CN, 0 to 700° C. for all others.

Equation: $C_p^\circ = a + bt(1) + ct(2)$

Units: cal./g-mole • °C. or °K.
Btu./lb.-mole • °F. or °R.

COMPOUND	T.	a	b • 10^2	c • 10^5	ERROR Maximum Percent	ERROR Average Percent
$(CN)_2$	°C.	13.39	1.1271	−6.571	0.99	0.42
	°K.	9.82	1.4858	−6.571		
	°F.	13.19	0.6390	−2.028		
	°R.	9.82	0.8256	−2.028		
HCN	°C.	8.43	0.6956	−2.611	1.42	0.76
	°K.	6.34	0.8375	−2.611		
	°F.	8.31	0.3912	−0.806		
	°R.	6.34	0.4653	−0.806		
CNCl	°C.	10.51	0.7871	−5.265	0.97	0.58
	°K.	7.97	1.0745	−5.265		
	°F.	10.37	0.4474	−1.625		
	°R.	7.97	0.5969	−1.625		
CNBr	°C.	10.97	0.6700	−4.367	0.85	0.54
	°K.	8.82	0.9084	−4.367		
	°F.	10.85	0.3867	−1.348		
	°R.	8.82	0.5047	−1.348		
CNI	°C.	11.42	0.5429	−3.265	0.75	0.37
	°K.	9.69	0.7213	−3.265		
	°F.	11.32	0.3080	−1.008		
	°R.	9.69	0.4007	−1.008		
CH_2CN	°C.	11.97	2.2658	−9.111	0.45	0.26
	°K.	5.09	2.7634	−9.111		
	°F.	11.56	1.2765	−2.812		
	°R.	5.09	1.5352	−2.812		
$CH_2{=}CHCN$	°C.	14.49	3.17×1	−16.939	0.63	0.41
	°K.	4.55	4.1039	−16.939		
	°F.	13.93	1.7689	− 5.228		
	°R.	4.55	2.2799	− 5.228		

[5] Ibid., **28**, No. 3, 175 (1949).
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* * *

Army's Mobile Petroleum Laboratory Inspected at Bayonne

Officials of the Bayonne refinery, Tide Water Associated Oil Company, are inspecting the U. S. Army's mobile petroleum testing laboratory set up at the plant recently for the instruction of the company-sponsored Army Affiliated Petroleum Base Laboratory Unit No. 982. Left to right are Colonel Theodore L. Preble, U. S. Army Reserve Corps, supervisor of the company's automotive transportation section of the sales operating department in New York; Frank W. Keebler, assistant general superintendent at the Bayonne refinery; George C. Caine, general superintendent of the plant, and 2nd Lieutenant John G. Welch, Army Quartermaster Corps, in charge of the mobile lab unit. The mobile laboratory is maintained by an officer and four other Army men.

The Tide Water affiliated unit, Lieutenant Michael Reseter, commanding, received instructions in the operation of the mobile laboratory, while all refinery employes had the opportunity to inspect the testing laboratory on wheels. These mobile units, it was pointed out, will be moved up to the fighting fronts in case of a national emergency and will be manned by units such as the one at the Tide Water refinery.

The company also sponsors a Chemical Smoke Generator Company at the Bayonne refinery and a U. S. Army Petroleum Distribution Company at its New York office, both under the command of U. S. Army Reserve Officers.

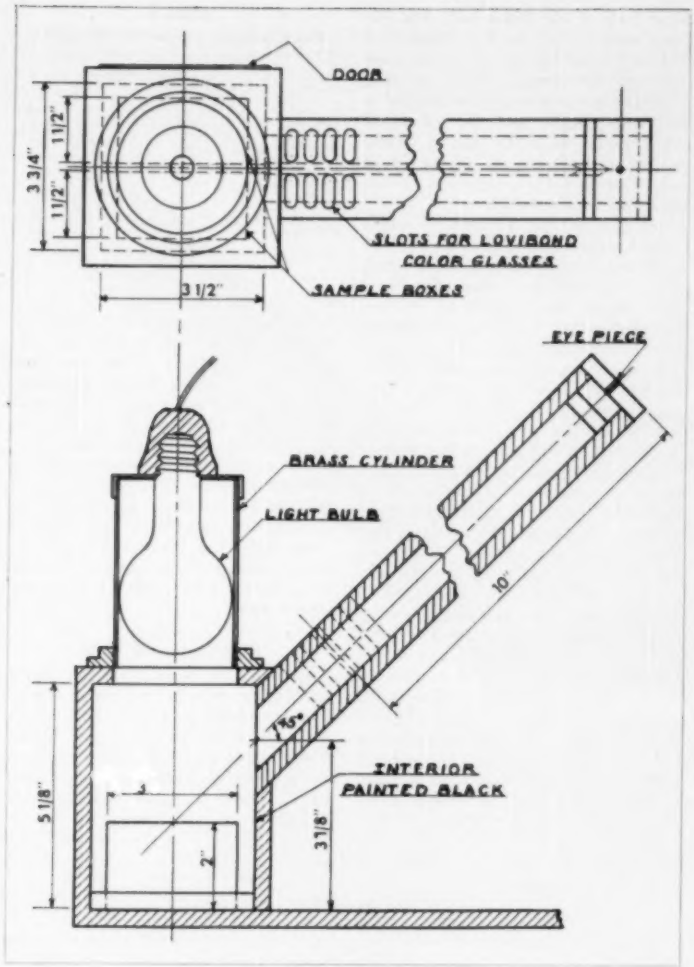

Figure 1. Diagram of Bloom Colorimeter.

Determination of Bloom Of Lubricating Oils

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ONE characteristic which is generally considered as an indication whether a lubricating oil is of paraffin or naphthene base is its "cast" or "bloom." This property, which is due to fluorescence, can best be observed by looking at the oil at an oblique angle. Most oils exhibit fluorescence in varying degree and the fluorescence of mineral oils is supposed to be due to the presence of asphalt-like material in colloidal suspension. In transmitted light the color of mineral oil varies from a light yellow to a deep red; in reflected light the oil usually exhibits a yellow-green or blue appearance on the surface, regardless of its color in transmitted light.

Paraffin base oils, conventionally refined, and also some mixed base oils, usually have a yellow-greenish bloom, but the cast of naphthene oils is generally blue-green. Improper treatment of paraffin base oils may destroy the yellow-green bloom; on the other hand, some naphthene base oils, by special treatment, may acquire a yellow-greenish cast. This being the case, the bloom of a lubricating oil has only a limited value in the determination of its origin; none-the-less, the yellow-green cast is generally associated with Pennsylvania (paraffin base) oils, which are considered superior to naphthene oils and for this reason the determination of the bloom has practical importance from the standpoint of consumer acceptance.

However, no reference was found in the literature to a system for expressing the bloom in quantitative terms. The method by Henderson and Cowles[1] utilizes a modified Ives tintometer and expresses the bloom as a light transmission curve—the wave length of greatest percent transmission determining the type of bloom. Their procedure is apparently not in active use. It is accordingly the purpose here to describe a method for determining the bloom of oils which is simple to perform and which expresses the bloom numerically. The method is based on the use of a modified Lovibond tintometer and Lovibond color glasses. The results are expressed by the designation "bloom index."

A METHOD for determining the "bloom" of oils is described by the authors, whose work along this line is well known to Petroleum Refiner readers. This bloom is quantitatively expressed by the "bloom index" which is the excess of yellow color units over blue or excess of blue color units over yellow. The bloom or "cast" is generally accepted as indicating whether a lubricating oil is of paraffin or naphthene base and thus determination of the bloom has practical importance from the standpoint of consumer acceptance.

Principle of Method

As mentioned, the bloom is best noted by looking at the oil at an angle.

TABLE 1

Bloom of Pennsylvania and Non-Pennsylvania Lube Oils

SAMPLE	Transmitted Lovibond Color[1] R	Reflected Color B	Y	R	Bloom Index
100 Percent Non-Pennsylvania Oil	4½	17	6	3	11B
75 Percent Non-Pennsylvania Oil + 25 Percent Pennsylvania Oil	8½	13	8	3	5B
50 Percent Non-Pennsylvania Oil + 50 Percent Pennsylvania Oil	12	11	8	3	3B
25 Percent Non-Pennsylvania Oil + 75 Percent Pennsylvania Oil	14	11	10	3	1B
100 Percent Pennsylvania Oil	16	11	12	3	1Y

[1] All colors in transmitted light were determined in ½" cell using 35Y glass color slide in addition to the red slides listed in the table.

To accomplish this a regular Lovibond tintometer was joined to a box at an angle of 45° with the base. The box in which the sample is placed is painted dull black on the inside and is fully enclosed on all sides to eliminate stray light. The sample is illuminated by a 40-watt daylight lamp mounted in a 2-inch brass tube in the center of the box top. Sample containers are made of brass 3 x 1½ x 2 inches deep. They are blackened by dipping them in a solution of copper nitrate and heated at approximately 400° F. for a few minutes. The blackening of the containers is important as only thus all light penetrating the oil surface is absorbed and not reflected back.

The sample occupies one half of the box. In the other half is placed a solid block of plaster of Paris, having the same dimensions as the sample container. (Or this block can be substituted by a milk glass or a porcelain plate placed at the level of the sample.) These serve as "standard white" from which departures of color are measured.

Method of Determination of Bloom

Apparatus Required

1) A modified Lovibond tintometer joined to a black box at a 45° angle. (Figure 1.)

2) Lovibond color glasses of the Blue, Yellow and Red Series.

3) Brass sample containers 3 x 1½ x 2 inches deep blackened on the inside.

4) A sheet of milk glass having a surface 3 x 1½ inches, or a sample container filled with plaster of Paris to serve as a "standard white."

Procedure for Determination

Pour the sample into the blackened container and place it in the right hand half of the black box. Put the "standard white" in the black box adjacent to the left of and on the same level as the sample. When sighting through the eye piece of the tintometer both the sample and the "standard white" must be in the line of vision. A 40-watt bulb on top of the black box illuminates the sample and "standard white." (Figure 2.)

Insert a 10-blue, a 10-yellow and a 5-red Lovibond color glass in the left-hand side slots of the tintometer which are in line with the "standard white." First adjust the amount of red required to match the sample's reflected color. This is easily done because small differences in red are readily distinguished. Then add or subtract blue glasses until the shade obtained matches the sample. Finally a slight adjustment of red may be required.

When the shade is closely approximated the intensity of the bloom is matched by adding or subtracting equal amounts of blue and yellow (and possibly a slight adjustment of red). After the operator is satisfied that he has matched the sample as closely as he can, he then checks himself by placing the 1-blue glass in the left hand and then in the right hand side of the Lovibond sighting tube. If he had the correct amount of blue originally, he will find that, first, the left side and then the right side will appear to be too blue. This operation is repeated with the 1-yellow and 1-red glasses. After making any adjustments required the operator shall rest his eyes for at least 30 seconds and then again sight the sample. If he is still satisfied, he

TABLE 2

Bloom Index of Various Lubricating Oils

SAMPLE	Transmitted Lovibond Color, R	Reflected Color B	Y	R	Bloom Index
Bright Stock A	80	10	17	4	7Y
Bright Stock B	75	10	14	4	4Y
Bright Stock C	60	10	13	3	3Y
Bright Stock D	25	14	12	1	2B
180 Neutral A	1	12	9	10	3B
135 Neutral B	3½	12	8	5	4B
180 Neutral C	3½	13	8	7	5B
200 Neutral D	4½	14	9	7	5B

then records the bloom of the sample by subtracting the total of yellow from the blue, if more blue was used; or by subtracting the total of the blue from the yellow, if more yellow was used. Fractions need not appear in the final result—the closest whole number being recorded as the bloom index.

For example, if a sample yields a reflected color of 17 blue, 6 yellow, 3 red, its bloom index is recorded as 11 blue. If a sample yields a reflected color of 10 blue, 13 yellow, 2 red, its bloom index is 3 yellow. The theoretical basis for this notation will be discussed later.

Experimental Data

In order to show that the above method for determining bloom checks with actual experience, various blends were made with a blue-green bloom non-Pennsylvania oil and a yellow-green bloom Pennsylvania SAE 20 and their blooms were determined (Table 1). The colors are abreviated as follows: B for blue, R for red and Y for yellow.

TABLE 3

Reproducibility of Reflected Color

SAMPLE	Operator A B	Y	R	Operator B B	Y	R	Operator C B	Y	R
100 Percent Non-Pennsylvania Oil	19	8	2	18	6	3	17	6	3
75 Percent Non-Pennsylvania Oil + 25 Percent Pennsylvania Oil	15	10	3	13	7	3	13	8	3
50 Percent Non-Pennsylvania Oil + 50 Percent Pennsylvania Oil	14	11	3	12	9	3	11	8	3
25 Percent Non-Pennsylvania Oil + 75 Percent Pennsylvania Oil	12	11	3	11	10	3	11	10	3
100 Percent Pennsylvania Oil	11	12	3	11	12	3	11	12	3
200 Neutral D	18	12	6	14	9	7	15	10	7
180 Neutral C	17	12	7	14	10	8	13	8	7
135 Neutral B	16	12	5	12	8	6	11	7	5
180 Neutral A	14	10	10	12	9	10	12	10	10

TABLE 3a

Reproducibility of Bloom Determination

SAMPLE	BLOOM INDEX Operators A	B	C	Mean	Maximum Deviation From Mean
100 Percent Non-Pennsylvania Oil	11B	12B	11B	11B	1B
75 Percent Non-Pennsylvania Oil + 25 Percent Pennsylvania Oil	5B	6B	5B	5B	1B
50 Percent Non-Pennsylvania Oil + 50 Percent Pennsylvania Oil	3B	3B	3B	3B	0
25 Percent Non-Pennsylvania Oil + 75 Percent Pennsylvania Oil	1B	1B	1B	1B	0
100 Percent Pennsylvania Oil	1Y	1Y	1Y	1Y	0
200 Neutral D	6B	5B	5B	5B	1B
180 Neutral C	5B	4B	5B	5B	1B
135 Neutral B	4B	4B	4B	4B	0
180 Neutral A	4B	3B	2B	3B	1B

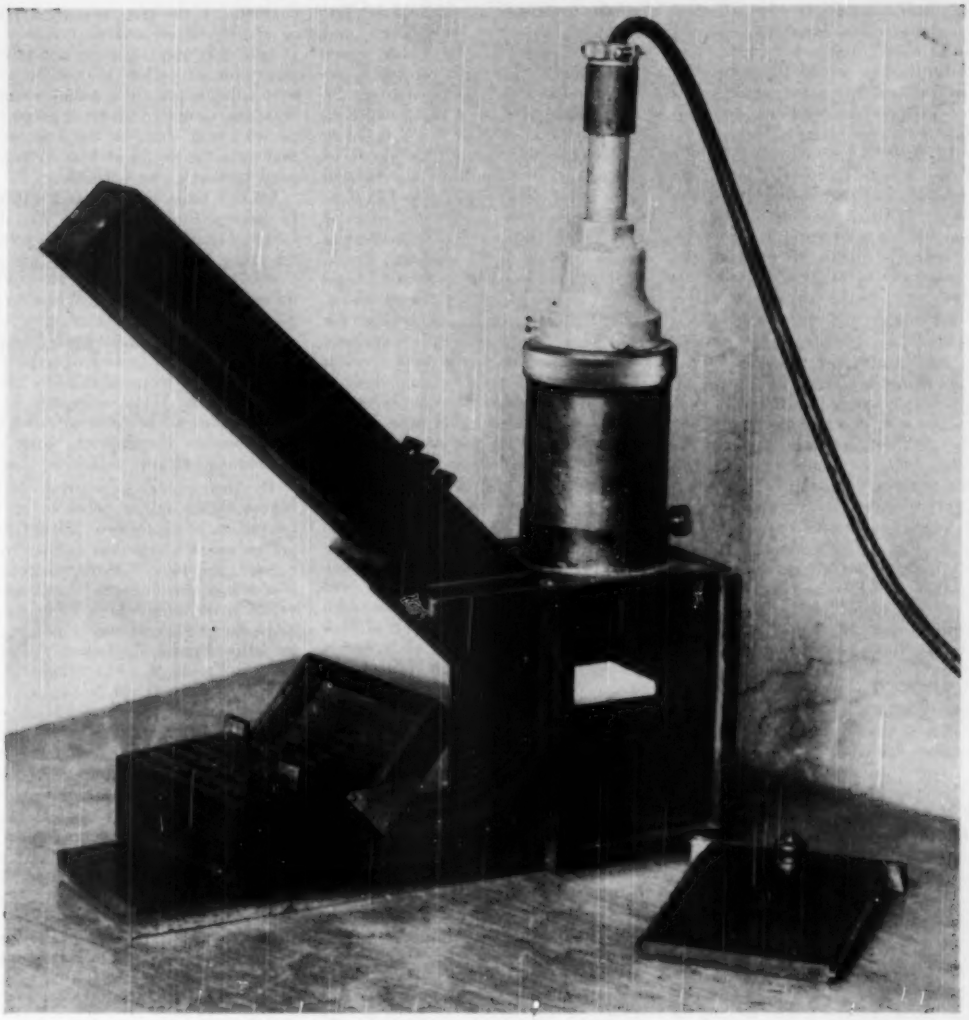

Figure 2. Bloom Colorimeter as Described in Accompanying Article.

It is apparent that the Bloom Index method rated the samples in the correct sequence, i.e. in the order of increasing content of Pennsylvania oil. In Table 2 are listed various samples of Bright Stocks and Neutrals, in order to show that this method is applicable to lube oils of widely varying colors and viscosities.

The data in Table 2 indicate the following:

1) The Lovibond Color in transmitted light does not influence the reading of the bloom.

2) The red component of the reflected color need only be used to get the correct match but is not to be recorded for the bloom index, because it has no influence on the character of the bloom. However, it does indicate whether the bloom is blue or violet in the case of blue blooms, or yellow or orange in the case of yellow blooms. For example, the 180-Neutral A has a violet bloom whereas the 135-Neutral B has a more bluish bloom. This could be predicted by the fact that both samples have a reflected color of 12B but the former has twice as much red. Since both violet and blue blooms are undesirable, the exact description is merely academic and for the sake of simplicity the red color is omitted in the calculation of the bloom index.

3) The method rates the samples in the same sequence as unaided visual examination, and is superior in that it expresses bloom numerically and at the same time is independent of transmitted color.

Reproducibility of Bloom Determination

Any analytical method must have a reasonable reproducibility in order to be of service. Therefore, samples of oils were tested by three different operators. The reflected colors and bloom indices obtained by the three operators are listed in Tables 3 and 3a.

The data in Tables 3 and 3a indicate the following:

1) The reproducibility of the bloom

index determination is very satisfactory—a maximum deviation from the mean of only 1 unit.

2) In the case of the 180-Neutral A the reproducibility was not so good and difference between the lowest and highest results was larger. This neutral is very light in color (only 35Y1R) and has a feeble bloom. Experience has shown that the lighter the color the more difficult the bloom determination and the more carefully must the experiment be made. If nothing else, the relatively poor results with this neutral indicates the necessity for careful matching of the reflected color.

3) The data in Table 3 do not indicate the good reproducibility borne out in Table 3a. The bloom index in Table 3a is recorded as the difference in yellow and blue and depends on the shade of color as determined by the operator. The total colors recorded in Table 3 refer not only to shade but to depth of color. It is the latter property which is hard to reproduce, but since it does not enter into the bloom index it does not influence the reproducibility of the method. For example, the reflected color of the 135-Neutral B varied from 16B 12Y to 11B 7Y but its bloom index showed no variation, because the difference between blue and yellow was constant. This is a special case of the well-known fact that intensity is harder to measure visually than shade of color.

Discussion

Two advantages are obtained by denoting bloom index as a difference between blue and yellow color:

1) The bloom of an oil can thereby be expressed by a simple number in combination with one of two letters.

2) The reproducibility is decidedly higher than the measurement of total reflected color.

The basis for the above method of bloom determination lies in the fact that Lovibond color glasses are internally equivalent and additive.[2] For example, 1B + 1Y = 1 Green, and 1B + 1Y + 1R = 1 Black. Since Bright Stock A (Table 2) has a reflected color of 17Y 10B 4R it can be converted to 13Y 6B 4 Black which in turn can be simplified to 7Y 6 Green 4 Black. In other words the bloom of this oil as expressed by the reflected color is yellowish-green. The 135 Nuetral B sample has a reflected color of 12B 8Y 5R which can be converted to 7B 3Y 5 Black or 4B 3 Green 5 Black. This oil then has a bluish-green bloom as expressed by the reflected color. Since the black has no influence on the type of bloom but simply expresses the brightness or purity of the color, this component can be dropped.

Some oils which have an excess of blue in their bloom may also contain red and any of the red in combination with the blue will form violet. In their effect on the eye, blue and violet blooms are very similar and thus we record only the blue in the bloom index. Any yellow which the oil originally contained is used to combine with the blue color to form green and thus almost all oils have some green in their cast. The combination of blue and yellow in the form of green is considered neutral so that only the excess of blue need be recorded.

In the case of oils having an excess of yellow, any red which is present will combine with the yellow to form orange. Again, yellow and orange are very similar in their effect on the eye and thus only the excess of yellow need be considered. If, as is usually the case, there is some blue in the bloom of an oil that has a predominantly yellow cast, the blue will be used up by combining with its equivalent of yellow to produce green which does not enter in the final bloom index.

We see that for practical purposes we can express the bloom of an oil either by the excess of blue or the excess of yellow. Any red which is originally present will merely alter the character of the blue, making it violet or of the yellow, making it orange. It is true that most oils do not have a pure blue or yellow bloom. Some of each color is present but they combine with one another to form a green cast so we again come to the conclusion that only the excess of blue or yellow need be taken into account.

On this basis, when a sample is said to have a bloom index of 7Y, it is inferred that the product has a yellowish-green bloom, the yellow being in excess by 7 units over the amount required to produce green. When a sample has a bloom index of zero, it is not inferred that the oil has no bloom, but that its yellow and blue components are equal and consequently, its bloom is true green. When a sample has a bloom index of 5B, it is inferred that the bloom is bluish-green, with blue predominating over yellow by 5 units.

In rare cases a positive yellow bloom index might refer to an oil having an orange-green rather than a yellow-green bloom but as previously argued, the exact description of the bloom is academic since it is the excess yellow over blue which is important and since orange bloom is as pleasing as yellow bloom. Analogously, in rare cases a positive blue bloom index might refer to an oil having a violet rather than a blue-green bloom; but again the differentiation is only academic since it is the excess blue over yellow which is important and violet bloom is considered as undesirable as blue-green bloom.

Briefly, then, the bloom index describes quantitatively the type of bloom (i.e. whether the oil has a yellowish or bluish bloom) but does not measure the intensity of the bloom. However, the latter property is psychologically of far less importance than the former.

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[1] Henderson, L. W. and Cowles, H. C., Jr., Ind. Eng. Chem. **19**, 74-76 (1927).

[2] Lovibond, J. W., "Measurement of Light and Color Sensations," page 16, G. Gill and Sons, London.

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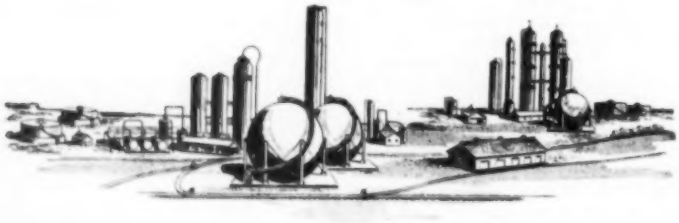


Figure 3. Tubercule Corrosion of Tubes in an Open-Box Cooler.

Design of Cathodic Protection For Open-Box Type Coolers

C. R. DRAUGHON, JR., and E. B. McNEIL
Esso Standard Oil Company
Baton Rouge, La.

***THE EFFECTIVE CONTROL** of corrosion on the water-side of open-box type coil coolers has been successfully achieved by the use of cathodic protection at the Baton Rouge refinery of the Esso Standard Oil Company. The severe corrosion encountered in this type of equipment, without protection, has resulted in high maintenance costs and frequent replacements. Cathodic protection has apparently arrested the corrosion to the extent that equipment is now being continued in service which otherwise would have had to be replaced. The economics of cathodic protection are indicated by the fact that an installation can be made for about one-third the cost of replacement—resulting in a reduction in maintenance cost to about 10 percent of the cost level without protection. The average cost of protection is about 66 cents per square foot of surface protected.*

This discussion was before a session on corrosion during the mid-year meeting of the API's Division of Refining, held early this month in Cleveland, Ohio. Mr. Draughon is head of the equipment-inspection department, Esso Standard Oil Company, Louisiana Division, Baton Rouge, La., and Mr. McNeil is an engineer for the same department.

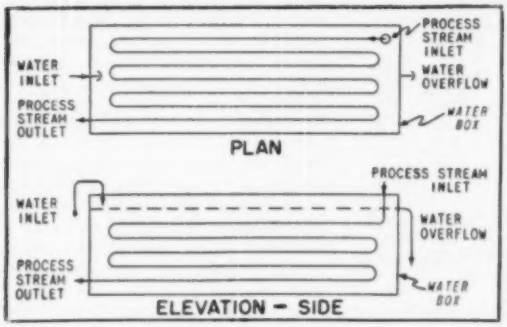


Figure 1. Typical Open-Box Type Cooler Details.

PIPE coils immersed in open-top water boxes or tanks were one of the first devices conceived for the purpose of decreasing the temperature of a continuously flowing stream. This type of equipment was probably used in the first petroleum refinery, and is still widely used, although it is gradually being replaced with the socalled shell-and-tube type of cooler because of excessive maintenance costs. The open-box coil cooler, an example of which is shown in Figure 1, is usually referred to in refinery terminology as a "worm." Although the cooling capacities and physical arrangements vary, the construction and operation are usually similar—with a process stream passing inside the coils, and with water or another cooling medium on the outside. The coolant is usually a raw water which can be cheaply obtained; in many cases it is salt sea water, brackish water, or muddy river water —all of which are corrosive to steel equipment. At the Baton Rouge refinery of Esso Standard Oil Company an attempt is being made to retard or prevent this water-side corrosion by the use of cathodic protection, and thus to reduce the high maintenance costs on this type of cooling equipment. Also

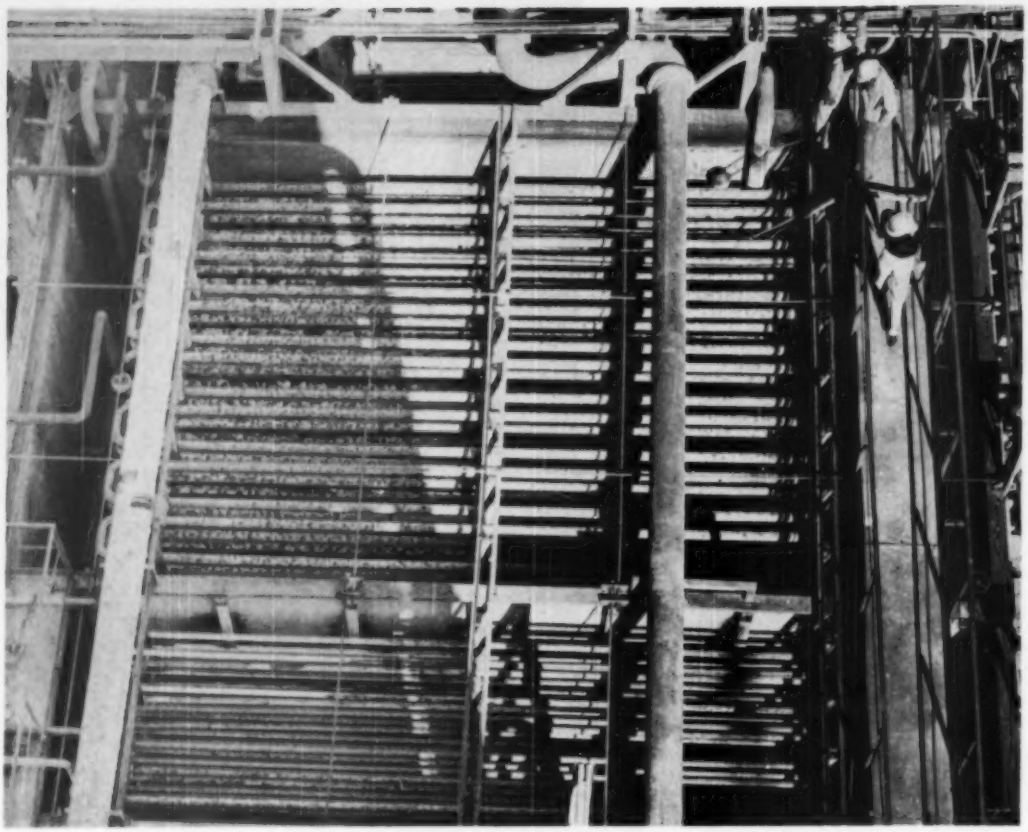


Figure 4. Typical Open-Box Cooler.

it is anticipated that replacements can be deferred for a considerable length of time, and that the extensive use of high-cost alloy steel can be avoided.

Through February, 1950, three such worm-type coolers have been protected. The first was of an experimental nature, wherein the cost was relatively high for protection obtained; but sufficient design data were obtained to enable providing more adequate protection for less unit cost on the next two installations. Recirculated cooling-tower water and raw Mississippi River water are the two types of coolants used at Baton Rouge, and their analyses are shown in Figure 2. As shown in Figure 3, the corrosion on the water-side of the tubes has been in the form of tubercules, which resulted in deep pitting and short life. It is estimated that the average service life of a steel cooler coil in river-water service is about three years, but this varies to some extent with the operating temperature.

A typical cooler box is pictured in Figure 4; it is the one on which the experimental cathodic protection unit was later installed. The pipe coils in this cooler had a service life of approximately 30 months, and the annual maintenance cost was estimated at $6000—with complete replacement costing about $15,000. Several methods of corrosion control were considered along with cathodic protection. Of these, cathodic protection was favored because replacement would not be required, and because the initial and operating costs appeared to be low. In addition, it was considered desirable to determine whether cathodic protection was a practical method of corrosion control on this type of equipment.

Figure 2. Baton Rouge Cooling Water Characteristics

		Well Water Recirculated in Cooling Tower	Raw Miss. River Water
ppm.	Total Alkalinity	254	90
	Total Hardness ($CaCO_3$)	24–30	90–115
	Total Solids	160–350	200–250
	Silica (SiO_2)	32	6
	Chlorides (NaCl)	48	40
	Sulphates (SO_4)	6	52
Turbidity			320
pH		8.9	8.0
Operating Temperature, °F.		170–190	120–180
Specific Resistance, ohm-cm.		560–1230	1040–1700

The cooler selected for the initial cathodic protection installation contains two carbon-steel coils—the coolant being well water, which is recirculated through a cooling tower. As shown in Figure 5, this compartment contains a cooling-surface area of 5440 square feet and a box area of 2156 square feet, or a total area of 7596 square feet requiring protection. When the installation was designed, there was little information available on the design of systems to protect open-box coolers. The meager data indicated that protection had been achieved with current densities anywhere from 1 to 8 milliamperes per square foot, and no water analyses were correlated with these data.

It was apparent from the start that

there were two main problems, viz.: current-density requirements, and current distribution. The data available formed the basis for an estimate that an average of about 3 milliamperes per square foot would be needed to give protection in water of our analysis, and that a potential change of 150 to 200 millivolts was to be expected, but not much more. Because of the experimental nature of the installation, it was decided to design on the basis of obtaining more protection than these estimates indicated would be needed. A total current capacity of 50 amperes was estimated to be necessary to protect the coils and the box, supplying an average of 6.6 milliamperes per square foot to the surface to be protected. The installation placed in service on this cooler consisted of the following features:

Rectifier

The rectifier installed is a standard copper-oxide oil-immersed unit rated at 15 volts and 100 amperes maximum direct-current (d.c.) output. The 100-ampere rectifier was selected so that sufficient capacity would be available to protect a similar cooler coil and box adjacent to the one described herein. Primary connection was for 440 volts, three-phase alternating current (a.c.). Control of the d.c. output was obtained by positive-contact link adjustment in 12 steps. A magnetic circuit breaker was used for electrical protection.

Anode System

Inasmuch as it appeared that more effective protection could be obtained with a large anode surface and close anode spacing, a total of 104 flat steel-plate anodes was installed as shown in Figure 6. Each anode was made of 3/8-inch plate, 12 inches wide, and 10½ feet long, extending to within 6 inches of the bottom. A center-to-center spacing of 30 inches was maintained except where limited by physical conditions in the box, and a row of anodes was installed parallel to and between every other vertical bank of tubes. Anode current density was set at 30 milliamperes per square foot, and it was estimated that a life of about four years would result. Anodes were suspended from supports in the top of the box, which were constructed of wood and structural steel (Figure 7). The wood also served as electrical insulation between the positive side of the rectifier and the box, which was negative. Wooden positioners in the bottom of the box held the anodes from swaying.

Electrical System

The details of the electrical system are given in Figure 8. All d.c. leads were designed to permit only a negligible voltage drop, so that the rectifier was supplied to a bus bar, and from there to the anodes. Current was drained from each vertical bank of tubes to a main drain lead, which also drained the box wall. The system was designed to provide electrical symmetry in both the anode and drain leads. Also a number of open-end leads were installed to permit a variety of experimental studies. All copper-to-steel connections were made by brazing.

Figure 5. Physical Data on Cooler Box for Unit I

TUBES	RETURN BENDS	Size	4½" Nominal
Size 4½" O.D.		Number	144
Number 144	AREA of Tubes and Return Bends		5,440 sq. ft.
Number Across 16	BOX	Size	38'x22'x11'
Number Down 9		Area	2,156 sq. ft.
Length 30'	TOTAL AREA of Tubes and Box		7,596 sq. ft.

The unit has now been in continuous service for 21 months since protection was initially applied. During this operational period numerous surveys were made on the cooler box, and considerable data were accumulated. The surveys made consisted of pipe-to-water potential and current-density measurements. All pipe-to-water potential measurements were made by the utilization of a calomel exploring electrode. Current-density surveys were made, and these used a probe consisting of a flat steel plate of small area which was connected into the protection circuit, together with a milliameter. The following is a summary of the data obtained on the protection unit during the 21-month period mentioned:

Potentials Along A Pipe

1) As indicated in Figure 9, readings taken along the length of any particular pipe show that the potentials are lower at points opposite the center of the space between anodes than at points on the pipe or wall surface directly opposite the center of an anode. Although the curve shown has been plotted from spot readings, it was found from the data that potentials on the pipe averaged about 15 percent lower between anodes than opposite anodes. Also, the distribution pattern was similar along the length of the pipe at any particular location.

2) Points of minimum protection are the box walls and corners, and the wall and coils in the center of the box where there are no anodes. This condition results from the lack of sufficient anodes to achieve satisfactory current distribution. In general, all areas of the coils where anodes were located were found to have high potentials. One exception to this was an area in the southeast portion of the compartment where an area of low potential was found. It was believed that this was due to an increased depolarizing action caused by vigorous agitation of the water which was noted in this location.

Potentials Across the Tubes

3) As seen in Figure 10, a trend in the readings taken in a north-south direction indicates a decrease in the pipe-to-water potentials toward the south end of the compartment. This might be explained by the fact that the water in this area is at a somewhat higher temperature and circulates more rapidly—thus causing increased depolarizing action.

4) The potentials on the top of the coils were found, on the average, to be approximately 30 percent higher than the potentials on the side of the pipe facing the anode, and 40 percent higher than the potentials on the side of the pipe away from the anode. Although the curve in Figure 10 indicates only spot readings, this trend can be seen easily. Higher potentials on the top of the pipe can be attributed

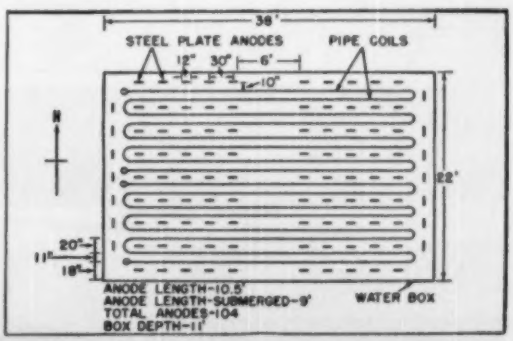


Figure 6. Anode-Arrangement Details for Protection of Unit I.

to a layer of scale which formed a protective coating at this point. Although it is present on the pipe tops without applied current, this precipitation of insoluble calcium carbonate and magnesium hydroxide is greatly increased when protection is applied. Prior to the installation of cathodic protection, it was observed that the most severe pitting had occurred on the top third of all pipe. Presumably these areas were deprived of oxygen by the scale and sediment, and had suffered anodic discharge to adjacent cathodic areas (pipe side and bottom) which received a plentiful supply of oxygen from the water and, consequently, suffered less corrosive pitting.

5) With a total rectifier output of 40 amperes, protection was achieved on approximately 65 percent of the coil-and-box surface area. This current supplies an average current-density of 5.3 milliamperes per square foot.

6) A greater improvement with time was shown in areas of minimum protection as compared with areas of maximum protection. This was true even though the total current applied decreased slightly. This could be attributed to a buildup in protection of the cathodic areas initially which, as time progressed, was extended to less protected or anodic areas. The extent of this increase in protection was not sufficient to achieve the desired results even after the total current through the system had been increased.

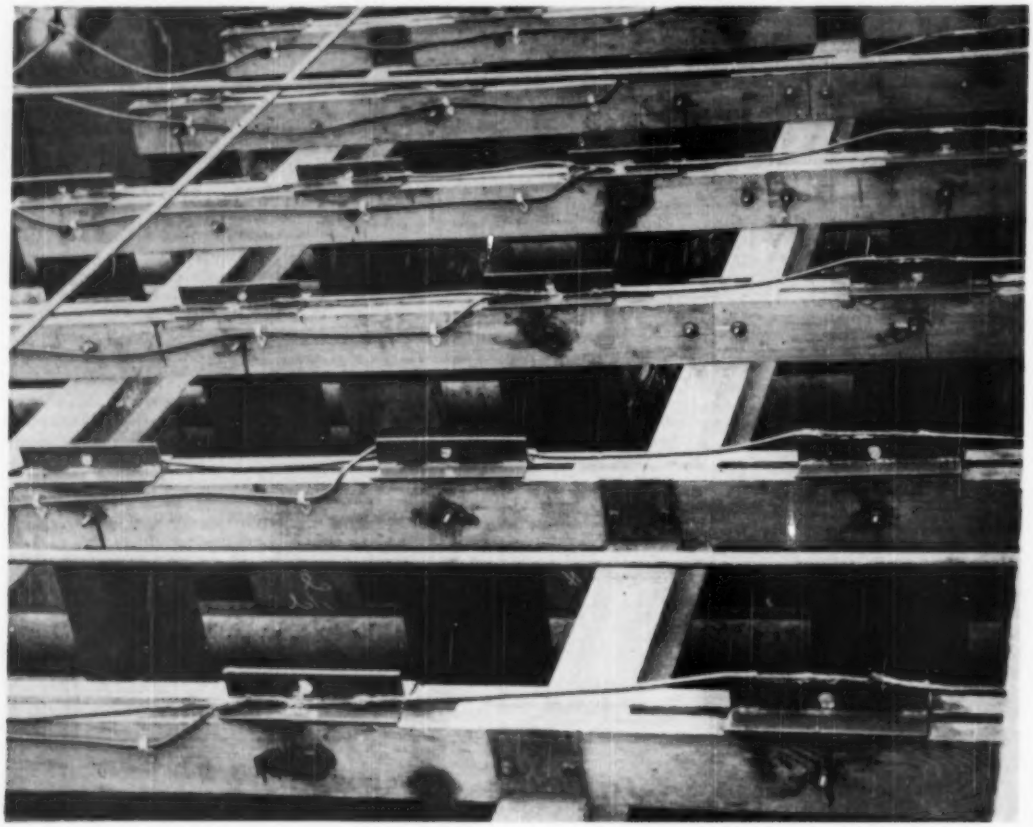
7) Pipe-to-water potential could be increased by increasing the rectifier output, although not in proportion.

8) It was also found that potential readings on the bottom of the box were somewhat higher than those of the coils. This higher potential is caused by a protective scale on the box bottom. Measurements made at different levels in the box indicated that, although the potential varies as much as 15 percent from the top coil to the bottom coil, no consistent variation in potential with depth had been noted.

9) To make a determination of the actual rate of corrosion with and without protection, carbon-steel samples were installed in the box. A total of six protected and six unprotected samples was placed in various locations. The average pit penetration based on the estimated area attacked was observed to be from 0.02 inch to 0.05 inch per year on all of the samples, as compared to 0.15 inch per year on the coils as determined prior to the installation of protection. It was impossible to establish a definite relationship between the amount of corrosion on a sample, its location in the box, and whether it was protected.

As a result of the surveys made during the initial period of protection, it was thought advisable that steps should be taken to achieve protection in the areas of low potential. It was decided to install additional anodes in the center portion of the coils and in the four corners of the box, and to increase the rectifier output to approximately 80 amperes—thus giving an average current-density of 10 milliamperes per square foot. The installation shown in Figure 11 consisted of installing 31 anodes in the center of the coils and in the corners of the box.

Figure 7. Close-Up of Anode Supports Showing Method of Connecting Positive Leads to Each Bank of Anodes.



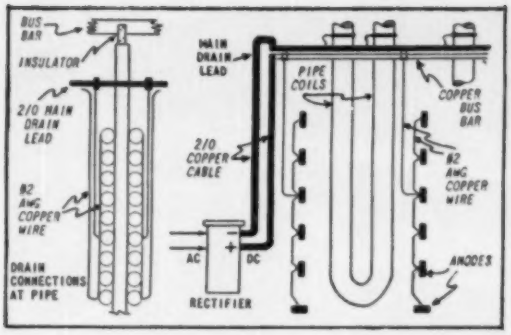


Figure 8 (left, above). Electrical Details for Protection of Unit I.

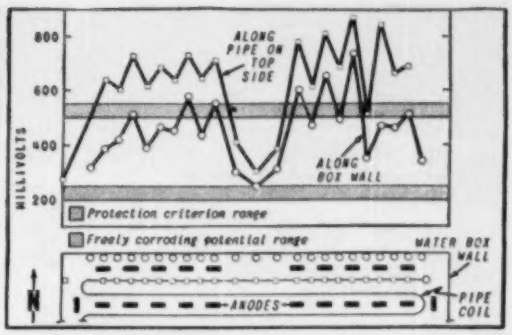


Figure 9 (right, above). Surface Potentials Along a Pipe. Unit I.

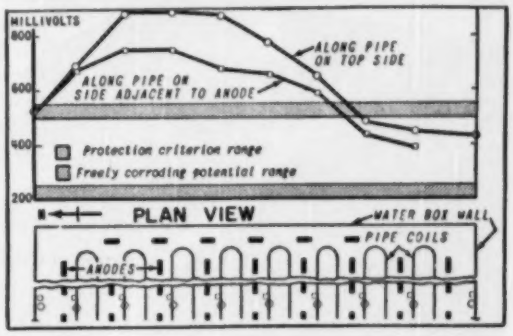


Figure 10 (right). Surface Potential Measurements. Unit I.

The anodes were graphite pipe, of 1 inch in outside diameter and ¾ inch in inside diameter. One anode was installed in each corner of the box, and three anodes were installed in each of the nine existing anode rows in the center of the coils. The additional anodes were connected in parallel to the existing electrical system. No additional drain leads were installed.

A survey of pipe-to-water potentials and current distribution indicated that increased protection has been afforded in areas of low potential and that greater protection has been offered in the high-potential areas. The area under protection has now been increased, so that 85 to 90 percent of the box and coil is now receiving full protection. This was the result of better distribution through the use of additional anodes, and through an increase in rectifier output and current density. With adjustments in the electrical circuit, it is believed that the entire area can be brought under full protection. This unit will be removed from service within a short time, and a complete inspection of the coils and box under protection will be made. Protection will have been applied for almost two years at this time, and it will be possible to determine whether cathodic protection has reduced the amount of corrosion. However, it may be brought out that the tubes were two years old at the time cathodic protection was provided—giving a total life of four years, as compared with an expected life of two and one-half years without protection.

Protection of Other Cooler Boxes

Because of the favorable results obtained in the first installation, protection units were installed in two additional open-box coolers. Protection of these coolers resulted in a saving of more than $10,000 by the elimination of the necessity of replacing the two coils. Unit II, costing $3100, was placed in service in September, 1949. In December of the same year, Unit III, costing about $2000, was completed and went into service. Both coolers are cooled with untreated Mississippi River water, and have an estimated service life of from four to five years without cathodic protection. Because the design for both units is similar, only the installation details of Unit II will be given. Physical data on the cooler are shown in Figure 12.

Rectifier

The rectifier is rated at 75 amperes and 12 volts d.c. output, and is a standard selenium oil-immersed unit, complete with a thermal overload relay, volt and ammeter, and power switch. This rectifier has a capacity slightly larger than design requirements of 60 amperes, as this was the nearest size available without encountering undue delays in delivery. However, it provides excess capacity, which can be utilized if deemed desirable.

Anode System

From our previous experience it was felt desirable to utilize cylindrical anodes placed closer together, instead of the flat plate, for the purpose of affording better distribution of current. Carbon steel was chosen as an anode material in order to reduce initial costs. Concrete reinforcing rods, 1 inch in diameter and 9 feet 2¾ inches in length, were utilized throughout—thus permitting rapid installation. Figure 13 shows the anode arrangement. The spacing between anodes is 16 inches, and the arrangement was designed so as to provide for an anode row between the outer row of tubes and sides of the box—thus assuring satisfactory protection for the box itself. There is a total of 189 anodes, each having an estimated life of three years. Figure 14 is a picture of this cooler taken as the installation was being completed. Anode supports consisted of wood sleepers which held the lower end of each anode in place, and which also insulated the anodes electrically from the box bottom. The upper end of each anode was held by welding into a 2-inch by 2-inch angle running along the top of each anode row. Size 3-inch by 3-inch angles supported the anodes on the top of the box, and 3-inch by 4-inch timbers served to insulate the supports from the anodes.

D.C.-Current Leads

All positive and negative leads were designed to permit only a negligible voltage drop, thus reducing the required rectifier output voltage. This was particularly important in the negative leads in order to drain all current supplied to the system while at the same time preventing a portion from leaking off to adjoining structures. Insulated No. 00 American wire gauge stranded-copper cable was used for all

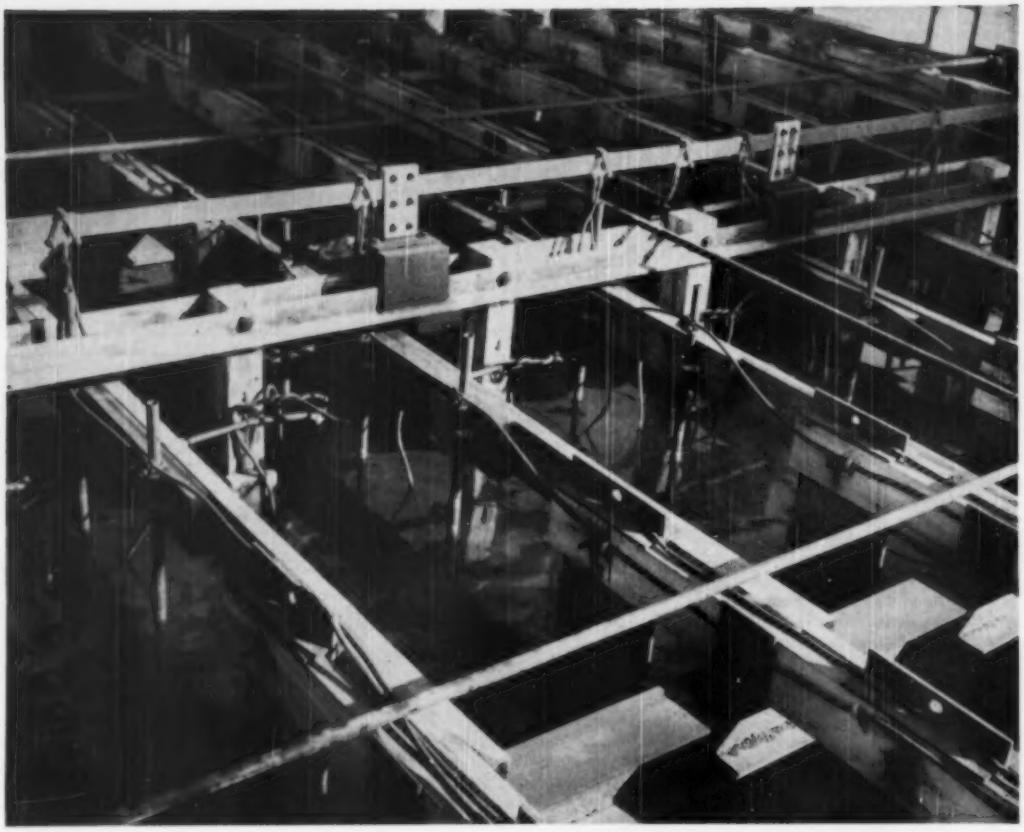


Figure 11. View of Additional Anodes Installed in Center of Box.

main leads. Secondary leads utilized No. 4 Awg. copper wire. The upper anode-support structure, constructed of 2-inch by 2-inch angles, was also used for part of the positive circuit in order to reduce construction costs and to eliminate the use of more expensive copper cable. In addition, more even distribution of current to the anodes resulted. The current-drainage system was simplified over that used in the previous installation. Each end of every two tubes was drained by bonding a negative lead to each return bend in the worm. The box was drained at six points—this bonding being done on the outside of the box, for convenience. Wherever possible, all electrical connections utilized thermite bonding.

Insulation

All pipe lines to and from the cooler were insulated aboveground, using standard flange insulators. This was not done on the previous installation.

Results of Protection

There has not been sufficient time to make the desired detailed study of the last two installations since their completion. Several surveys have been made on Unit II, and preliminary measurements obtained on Unit III. From the available data, the following results are known:

1) Complete protection of all portions of the coils and box on Unit II has been achieved with a total rectifier output of 60 amperes, giving an average current density of 10.8 milliamperes per square foot. Initial meas-

Figure 12. Physical Data for Cooler Box for Unit II

TUBES			
Size	4½" O.D.		
Number	121		
Number Across	11		
Number Down	11		
Length	32'		
RETURN BENDS	Size	4½" Nominal	
	Number	110	
AREA of Tubes and Return Bends		4,280 sq. ft.	
BOX	Size	36'x12'x9'	
	Area	1,296 sq. ft.	
TOTAL AREA of Tubes and Box		5,576 sq. ft.	

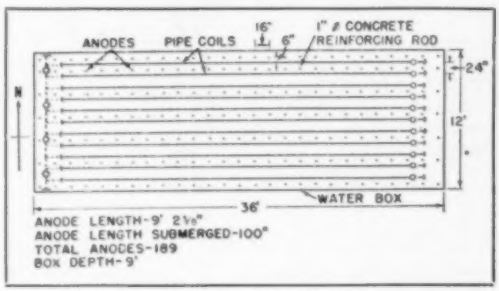


Figure 13. Anode Arrangement Details for Protection of Unit II.

urements of protection of Unit III indicate similar results.

2) Distribution of current throughout all parts of the coil and box on Unit II is excellent, there being no areas of low potential. The ratio of minimum to maximum surface potential has been roughly established at between 80 and 85 percent.

3) There is no great difference in potential between the top and bottom of the box.

4) Although potential values are different, the pattern of distribution is similar to that found previously.

5) The drainage system, although simplified, is ample.

Conclusions

As a result of two years of experimentation on cathodic protection of open-box coolers, it has been possible to draw the following conclusions:

1) Cathodic protection is an effective means of controlling corrosion on the complex structures of open-box type coolers. Complete protection of the system involved can only be achieved through proper design and installation of the protection equipment. Although corrosion may continue after application of protective current, in a properly designed system this will take the form of a general metal loss instead of pitting, and will result in a greatly extended service life of the equipment.

Figure 15. Comparison of Cathodic Protection Costs

	Unit No. I Experimental	Unit No. II	Unit No. III	Total For II and III
Area Protected, Sq. Ft.	7,586	5,576	2,050	7,626
Replacement Value of Coil,$	15,000	11,500	4,200	15,700
Installation Cost, $	7,000	3,100	1,950	5,050
Operating Cost, * $/Year	96	36	10	46
Unit Cost, ¢/Sq. Ft.	92.2	.....	.....	66.3

* Does not include replacement cost of anodes.

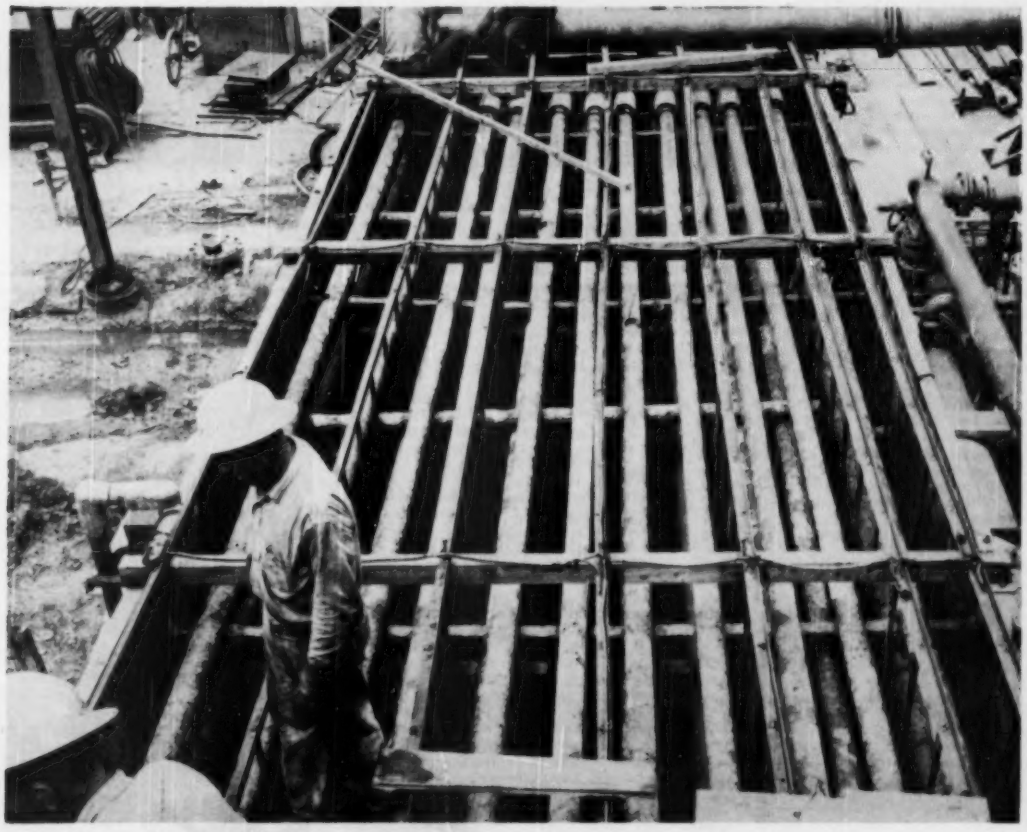
2) Economically, cathodic protection of this type of equipment can be justified because it eliminates the necessity of replacement of the corroded equipment, or because it reduces the cost of maintenance repairs, or both. This is shown in Figure 15.

3) To assure protection throughout any system, a sufficient current density must be maintained, and a large anode system with relatively close spacing between anodes must be had in order to distribute current equally. One will not suffice alone. A symmetrical distribution of current to the anodes should also be attained.

4) For water similar to that found at Baton Rouge, an average current density of 10 milliamperes per square foot is recommended for design purposes. Wherever vigorously agitated water is noted, this may not be sufficient because of the resulting depolarizing action.

5) The protection criterion used to determine the degree of protection in these installations has not been definitely established. However, to evaluate the success of the installations, a definite basis was necessary. Protection of the steel surfaces was assumed to have been obtained when the pipe-to-water potential in a freely corroding condition as referred to a saturated calomel electrode was increased negatively by 250 to 300 millivolts.

Figure 14. View of Unit II Showing Anode Leads.



New Plant For Blending And Packaging

Above—One-quart lube oil cans are filled at the average rate of 260 per minute by this machine at Sun's Marcus Hook. Controlled by the operator (right center), cans are filled at the right, capped and then moved along where, to the left of the picture, is shown the second man necessary in this operation who is filling the 24-can cartons at a semi-automatic loading machine.

Right—Aerial view of Sun Oil Company's new $6 million compounding, blending, filling, packaging and warehouse plant at Marcus Hook, Pa. At far right are the base stock tanks and in the right foreground, the blending and packaging plant. The warehouse and triple box car siding are at the left. Part of the refinery is shown in the background. A tank ship is tied at the end of the wharf, far right.

A NEW $6 million oil blending, packaging and warehousing plant, now in operation at Sun Oil Company's Marcus Hook, Pa., refinery, features bigness and push-button efficiency. There are approximately seven acres of floor space under roof and a mile and a quarter of power and gravity conveyor lines.

Machinery takes over as soon as the packages and base stocks enter the plant, personnel principally "supervising" the machines. In the one-quart filling line, a typical operation, cans leave box cars by conveyor belt and are carried into the main building where they are routed direct to the filling machine or sent to storage.

This rotary filler, designed to handle 43,000 gallons of lubricating oil per eight-hour shift, averages 360 quart cans a minute. Cans leaving the capping unit are boxed mechanically in cartons which then are automatically glued top and bottom before moving along by conveyor belt to a pallet loader.

Ninety base stock tanks with a total capacity of 660,000 barrels are hooked up to three continuous blending units. One unit is a five component 350-gpm. unit for high velocity index oils; a second seven component unit of the same capacity handles low viscosity index oils and the third, of five components, can blend 250 gpm. of industrial oils.

Connected to the blending units are 24 tanks in the building, each with a capacity of 12,000 gallons, where products are held temporarily for laboratory approval. The present demand on this section is to blend approximately 350 finished products although units can be set for many others.

Blended oils are pumped from the product tanks to drum fillers, can packaging equipment, tank car and tank truck loading points. The blending machines also are piped to discharge the blended oils directly to tank cars and tank trucks. Products leaving the blending section for the filling area can be routed in six ways. There are lines handling one and five quart cans and one, two, two and one-half and five gallon containers.

In the packaging section there is a wholly enclosed platform where all incoming small containers and cartons are unloaded, and the same cars reloaded for out-going shipment. This includes two railroad tracks (space for 15 box cars) with a 20-foot concrete platform between.

On one side is a sheltered platform paralleling three railroad tracks for the unloading of drums from box cars and trucks or loading of cars. On another side is a sheltered truck shipping platform at which 18 highway carriers can be loaded simultaneously. Toward the river is the wharf where facilities have been installed for the loading of lighters.

Below—Lithographed one-quart lube oil cans are received in bulk at Sun's Marcus Hook refinery and loaded by hand on a conveyor which feeds the empty cans direct to the filling machines. Two men, one each to a box car, use "fork sticks" in this unloading operation.

Maintenance Practices In a Small Refinery

JOHN S. PFARR, ROBERT W. POLLARD, LEON T. HARRIS and WILLIAM F. DOUGHERTY

Leonard Refineries, Inc., Alma, Mich.

A SMALL REFINERY, because of its relatively high unit cost of operation, can compete with large refineries only by maintaining a high degree of flexibility in its operations. Such flexibility depends, to a large extent, on the versatility and efficiency of its maintenance department, especially because it cannot afford to invest heavily in standby equipment or spare parts.

The Alma, Mich., refinery of Leonard Refineries, Inc., with a crude capacity of 8500 bbl per day, achieves the necessary flexibility by means of a well balanced maintenance program. The maintenance staff totals 34 men, most of whom are trained to handle more than one type of job. This group is assisted in its task by the operating personnel, 10 per shift, who carry out continuous on-the-spot inspection and repairs.

The regular operations of the maintenance department are divided into three categories: 1, housekeeping, which includes picking up, cleaning, and painting; 2, general maintenance, which may be described under such headings as safety, purchasing and storeroom operation, regular plant maintenance, salvage, and miscellaneous construction; and 3, inspection and cleanout, which are handled on a regular yearly cycle, with the assistance of outside inspectors and engineers.

This paper was before a session on Refinery Maintenance during the midyear meeting of the API's Division of Refining held early this month in Cleveland, Ohio. The authors are with the Alma, Mich., Refinery of Leonard Refineries, Inc. Mr. Pfarr is vice president in charge of manufacturing, Mr. Pollard is general superintendent, Mr. Harris is maintenance superintendent, and Mr. Dougherty is refinery engineer.

IN THE MODERN small refinery one will find almost the same processing equipment as in the large refinery, with one notable exception. That exception is what is known as spares or standby equipment. The small refiner must use his capital to keep pace with technological improvements, and these improvements must be purchased at the barest minimum cost which, as a general rule, does not include much duplication of equipment. Such spares as are found absolutely essential are added later after experience has shown where the dollar spent will bring in the greatest return. For this reason maintenance practices in a small refinery are of paramount importance.

Inasmuch as a small refiner's equipment, because of smaller capacity, costs as much (or more) per barrel to construct as that of the large refiner; as his main raw product (crude oil) costs are comparable per barrel; and as other materials probably cost more due to smaller quantity discounts, the small refinery can keep his costs in line and compete with the large refiner for only one reason, namely, flexibility of operations. Flexibility of operations depends to a great extent on the versatility and the flexibility of the maintenance department.

Our refinery consists of a crude unit with an 8500 barrel-per-day capacity; a TCC catalytic cracking plant, with a 5000 barrel-per-day reactor-charge capacity; an 1800 barrel-per-day UOP thermal reforming unit; a 1000 barrel-per-day vacuum unit for asphalt production, with auxiliary oxidizing equipment; steam-generating equipment with a capacity of 50,000 pounds per hour; 60 storage and rundown tanks, with a total capacity of 472,000 barrels; a tetraethyllead (TEL) plant; control and research laboratories; truck and tank-car loading rack; and the normal auxiliary equipment which would be expected in a plant of this size.

Our maintenance department, according to personnel records, is made up of 34 men as follows: 1, maintenance superintendent; 1, machinist foreman; 1, pipefitter and labor foreman; 1, painting and insulating foreman; 1, electrical foreman; 1, instrument enginer; 1, pipefitter first-class sub-foreman; 1, storeroom manager; 1, first-class welder; 1, first-class carpenter; 1, first-class painter and insulator; 1, first-class machinist; 1, second-class machinist; 1, second-class pump mechanic; 1, second-class painter and insulator; 3, second-class pipefitters; 6, pipefitter helpers; 1, painting and insulator helper; 1, carpenter helper; 3, yardmen first-class; 2, yardmen second-class; 3, process extra board.

The maintenance superintendent, electrical foreman, instrument engineer, and the storeroom manager are on the salary payroll. All of the other personnel in the maintenance department are on an hourly rate. Such a system eliminates confusion as to when overtime should be paid, as all of the foremen are working foremen, and frequently are working on jobs alone. The men are shifted by the maintenance superintendent as the various jobs require, and are not assigned to a particular department except for normal routine work (something which rarely exists in a small refinery).

As an example, the first-class welder is kept busy approximately 75 percent of his time on welding. However, the painting and insulating foreman is a trained welder, and the master mechanic is proficient in that work. Whenever a job arises wherein welding will be the bottleneck, all three are put on this job—either together or on shift work—with helpers being assigned as required. Occasionally, even this flexibility will not meet the requirements, and we may have to get on the telephone and borrow a welder or two from a neighboring refinery. This is always an easy task, as these refinery people know that we shall be ready

at any time to lend our craftsmen in an emergency.

However, the records of the maintenance-department personnel by no means tell the entire story. We have on each shift one man on the crude unit, three on the TCC unit, two on the reformer, one at the asphalt plant, one pumper, one at the boiler house, and one at the truck-loading dock. These 10 men per shift are an extremely important part of our maintenance organization. Almost without exception they have had valuable training in the regular maintenance department. Even more important, they know that their work is easier and more pleasant when their unit is running than when they are starting it up or shutting it down. Consequently, they are at all times practicing preventive maintenance; and, whenever an occasion arises wherein they can safely handle minor repair maintenance, they do it as part of their job.

Equipment

The maintenance equipment consists of the following: 1, 2½-ton truck with 20-ton winch and a frame; 1, 1½-ton combination flat-rack and dump truck; 1, 1-ton stake-rack truck; 1, 1-ton pickup truck; 1, Jeep, equipped for light bulldozing or snow plowing; 1, caterpillar tractor, T-20; 1, tractor, equipped with mowing sickle to operate through a 90-degree arc; 3, engine-driven PUP pumps, mounted on skids; 2, engine-driven 500 gallon-per-minute fire pumps, mounted on wheels; 2, foam generators; 1, trailer foam carrier, 3-ton capacity; 3, 2-inch gasoline-driven centrifugal pumps, mounted on wheels; 1, P-12 with 3-inch herringbone gear pump; 1, P-12 with 4-inch herringbone gear pump; 1, turbine sump pump, air-driven; 1, portable steel scaffolding equipment to produce scaffold 3 feet x 4 feet x 40 feet; 3 feet x 8 feet x 20 feet; 6 feet x 8 feet x 10 feet; or other proportionate sizes; 1, 2-inch portable threading and cutting machine with attachments to 6-inch (practically all pipe work over 2-inch is welded); 1, hydraulic cold pipe bender with dies to 4-inch; 1, 6-foot bed lathe; 1, 8-foot bed lathe; 1, bench lathe; 1, drill press with chucks to 2-inch; 1, drill press with chucks to ½-inch; 1, 50-ton hydraulic arbor press; 1, 1-ton hydraulic floor crane; 1, metal-cutting band saw; 1, 300-amp electric driven welder; 1, 300-amp gasoline-driven welder; 3, acetylene welding outfits; 1, type "S" metalizing machine.

In addition to the major equipment just listed, our maintenance department is adequately supplied with all of the necessary small tools which would be expected to be on hand as auxiliary to the foregoing list.

Division of Maintenance

In discussing maintenance practices, we believe that they should be listed in three main divisions, the first of which is housekeeping. We list this phase of maintenance first because we believe that it is first in importance. We are firmly convinced, however, that the money spent in good housekeeping pays large dividends. Our control rooms are not tile and marble, and we have no gold plate in the refinery; but we believe that we have one of the cleanest refineries in the country. We have a large number of visitors who go through the plant, and a large percentage of these write us complimentary letters concerning the appearance of the plant. These letters immediately become a part of our maintenance program; that is, copies are made and are put on the bulletin boards of each unit and the locker room. This, we believe, helps to uphold the pride of each employe in this phase of his job.

The operators of each unit are responsible for the appearance of their unit. They do the following work themselves: 1. Wash, with hose and hot water, all floors of the unit, each shift. If the floor is dirty from an oil spill, a hot solution of chemical penetrant, and kerosine is used in those spots; 2. Keep all packing glands on valves and pumps adjusted so that there are no leaks. In an emergency, they are to add necessary rings of packing. In the case of pumps on which leakage cannot be avoided, and when it is not practical to pipe this leakage to a drain, they maintain pans underneath the gland; 3. Clean up any spills as soon as possible. Major spills, of course, are handled by the maintenance department; 4. Pick up all trash, rags, etc., around the unit and put them into closed receptacles for that purpose. During spring, summer, and fall, each morning before the shift change, the limestone-chip-covered area around the unit is raked; 5. Inspect a job before the maintenance department is released from its responsibility for proper performance of the job, and before the operators again assume responsibility for the appearance of that particular part of the unit; 6. Request assistance, through the assistant superintendent, from the maintenance department when operators are temporarily unable to keep their unit in shape. This is usually due to some operating difficulty.

The maintenance department is responsible for duties in the housekeeping phase of maintenance, without special requests from either the general or assistant superintendent.

The department maintains clean and sanitary conditions in the locker room and plant offices (work in these locations requires the services of one man full-time), water pump house, truck-loading pump house, fire house; washes all windows in plant except locker room, plant office, laboratories, and boiler house. (Laboratory and boiler-house personnel wash their own windows. The work from the last four requires the services of one man full-time. Two men and a pickup truck are scheduled one-half day each day for general plant cleanup. These men empty all trash and rubbish barrels, deliver all used valves and fittings to the salvage department, and assist the units when so ordered. On Saturday morning the personnel of the entire maintenance department, except those on emergency jobs, take over the general plant cleanup. From 8:00 a.m. until 12 noon they work in cleaning and putting in order all shops, trucks, and equipment. The maintenance department does not work on Saturday afternoon or Sunday.

Painting

Another phase of our housekeeping program is painting. One department is devoted to painting and insulating. We have found that such an arrangement makes an ideal combination, because the general insulation maintenance, such as patching, can be taken care of as part of the preparation for painting. Of course, during regular shutdowns for inspection, the painting is stopped for the length of time required to remove, replace, and repair the insulation of the particular unit involved.

This department—composed of a working, painting, and insulating foreman; one first-class painter and insulator; and one second-class painter and insulator—spends the major part of its time painting. We list the cost of such painting for two typical years, as follows:

1945	
405 gal. of aluminum paint, at $4.09 per gal.	$1,656.45
125 gal. of all other colors, at $3.75 per gal.	467.50
100 gal of red oxide primer, at $2.55 per gal.	255.00
3,320 man-hours of labor, at $1.33	4,415.60
	$6,794.55

1948	
589 gal. of aluminum paint, at $4.40 per gal.	$2,591.60
189 gal. of all other colors, at $4.70 per gal.	883.30
120 gal of red oxide primer, at $3.37 per gal.	404.40
3,846 man-hours of labor, at $1.78	6,845.88
	$10,730.18

It will be noted that the man-hours versus gallons of paint used were high. The reason for this is that practically all of the painting consisted of pumps, towers, lines, small rundown tanks, and other similar equipment which takes a large amount of labor for preparation and application.

In addition to this painting program, which we call plant-force painting, we keep rigid appearance standards on our storage tanks. This painting, however, is handled by contract, and the contract is let each spring for the number of tanks which require painting (usually about one-fifth of the storage tanks, or 10 per year).

The same contractor has been handling this work for the past 10 years. We supply the paint, and he supplies the labor for preparation and application. The approximate price for this work for 1948 was as follows: 25,000-bbl. tank—$125 per coat; 10,000-bbl. tank—$80 per coat; 5000-bbl. tank—$65 per coat; 2000-bbl. tank—$40 per coat.

We let a contract two years ago for the painting of the TCC unit, but we found that this type of painting could be done much cheaper, and very much more satisfactorily, with plant painters.

Jurisdiction of Housekeeping Costs

Why do we spend the amount of money involved for this housekeeping program? First, we believe that it is tied in very closely with safety. Rigid controls on housekeeping cannot be maintained along with faulty equipment, leaking gaskets, makeshift repairs, and the like. Policing the unit frequently from the standpoint of cleanliness often calls attention to items which would become hazardous if neglected. Second, we know that it improves operating conditions and, therefore, improves yields. It is axiomatic that, if an operator is conscious of the appearance of his unit, he will not tolerate sloppy temperature control. Likewise, if he will not permit steam leaks, water leaks, or oil leaks, he will not permit a smoking furnace stack; neither will he permit a tank to overflow, or a product stream to continue to run off specification. We are not operating a refinery in Utopia, and we do not mean to infer that such conditions never occur. We do mean that our operating personnel are acutely aware of proper operating conditions and product quality, and we give a large share of the credit to their pride in the appearance of their equipment.

Third, our sales department and distributors use the plant to a large extent in obtaining new customers. We welcome and encourage our distributors to bring in groups frequently, and experience has shown us the product quality is easily "put across" if the prospective customer has been favorably impressed with the appearance of the refinery. Inasmuch as there would be no maintenance practices without customers, we feel that again, we have an important point for the housekeeping program.

General Maintenance

The second main division of maintenance we would classify as "general." This division should be discussed in several categories.

Safety

Safety meetings are conducted monthly by the maintenance superintendent. These meetings are held in the locker room at 12:30, the normal time for the lunch period to end. As a general rule, they last approximately one hour. A brief review of the last Michigan-Ohio fire and safety meeting, sponsored by the National Petroleum Association, is given. From our maintenance department, the maintenance superintendent and at least one other man have attended that meeting. The balance of the time is spent in an informal discussion of items which the men bring up in the interest of safety. The practice of safety by the men is shown by the fact that the maintenance department has completed 10 months without a lost-time accident, as well as a period of 8 years without an accident which could be considered other than minor. There has been no fatal accidents in either maintenance or operations since the plant started in 1936.

The men are all extremely conscientious in their safety program, and at all times they wear protective helmets. Safety shoes are not required, but are recommended; and many of our maintenance-department men wear the approved type.

Purchasing and Storeroom

This department is of vital importance to the general maintenance of a small refinery. All stock items are maintained by the well-known system of perpetual inventory and, as a general rule, this runs very smoothly. We carry a warehouse stock of parts, valves, fittings, pipe, and similar of approximately $75,000. Experience has determined that such a stock will take care of 90 percent of our needs. That unpredictable 10 percent may mean the difference between a breakdown of one unit for a short time, or a longer breakdown which might force down other units due to their semi-dependency. It is in these emergencies that the purchasing agent must be able to locate the necessary material almost immediately, and to arrange with the maintenance superintendent to get it to the plant. In this respect, the small refiner realizes the importance of purchasing from a manufacturer's agent. Such agent will always work with the purchasing department, and usually he knows where the material is located which can be spared until it can be replaced from the manufacturer. The purchasing agent's work in keeping a small refinery onstream never becomes routine or monotonous.

Regular Plant Maintenance

We operate on the plan of standing and special work orders. Standing work orders are numbered from 1001 to 1030, listed as follows: 1001, topping-plant repair and maintenance; 1002, TCC cleanout and inspection; 1003, treating-plant repair and maintenance; 1004, ethyl-plant repair and maintenance; 1005, asphalt-plant repair and maintenance; 1006, office-building maintenance; 1007, crude-unit cleanout and inspection; 1008, auxiliary-buildings maintenance; 1009, tank-car loading-rack maintenance; 1010, truck loading-rack maintenance; 1011, steam-plant repair and maintenance; 1012, tank-farm maintenance; 1013, control-laboratory maintenance; 1014, research-laboratory maintenance; 1015, general yard-equipment maintenance; 1016, oil-separator operating and maintenance; 1017, water-system repair and maintenance; 1018, sewer-system repair and maintenance; 1019, warehouse maintenance; 1020, closed out; 1021, closed out; 1022, TCC repair and maintenance; 1023, parking-lot maintenance; 1024, sales department request; 1025, general plant cleanup; 1026, reformer repair and maintenance; 1027, reforming-unit cleanout and inspection; 1028, closed out; 1029, lubricating-oil-department expense; 1030, Sales-department service-station expense.

As will be noted, all of the foregoing standing work orders cover only such work which can properly be properly be charged to expense. All

work which can be construed as capital investment must be handled by a special work order. A list of these standing (and all open special) work orders are posted at the storeroom window and in the locker room. All material requisitioned must carry a work order number. Each man, before he goes home, is responsible for filling out a time sheet which gives a brief description of the job, the time spent on the job, and the work order number. If, as is generally the case, the man has been on more than one job during the day, he lists all jobs on the same time sheet. The following morning the maintenance superintendent goes over the time sheets and approves each one. Inasmuch as so few men are involved, and as the superintendent is quite familiar with the location of all work in progress, he can approve these time slips and work order numbers in less than half an hour. Although a time clock is in use and time cards are checked against time slips, the work sheet which is made out and signed by the man himself is the official report used by the payroll department for determining the individual's pay check. Before this plan was adopted, we had had a lot of forgetfulness. Now, however, inasmuch as a man is put to considerable trouble in making out a time sheet after the due date has passed, such neglect is a very rare occurrence.

Special work orders must be requested by the general superintendent. They are numbered serially, beginning with No. 1, continuing through 900 and then starting again with No. 1. It would be confusing to go beyond 900, as operating-unit charges begin at that point. For instance, during 1948 there were only 37 special work orders issued; thus it can be seen readily that, at this rate, several years would elapse before special work order numbers would be repeated. Consequently, there can be no confusion in allocating labor and material to the proper job. As inferred previously, these special work orders are generally connected with new construction and, therefore, are capitalized. However, if isolated expense work arises which cannot be properly charged to a standing order, then a special order is issued.

Scheduling Work. How is the work scheduled? All of the foremen are quite familiar with the routine maintenance which comes under their department and the men who work under them on such jobs. They are also familiar with the work for which they are responsible on the open special work orders.

The foremen place their men, and they are working with them almost immediately after the whistle blows at 8:00 a.m. The assistant superintendent approves the maintenance requests, as listed in the operators' repair book, at each unit the first thing in the morning, and then meets with the general superintendent. As soon as the maintenance superintendent has finished approving the time sheets, he joins this meeting for a general discussion of the status of the maintenance department's work. At this meeting the urgency of the uncompleted special work orders is discussed thoroughly, and often this results in the shifting of one or more men to speed up one or more jobs.

Emergencies. An emergency, from the standpoint of the maintenance department, is a job which must be rushed in order to maintain throughput, or get a unit back onstream if it has had to be shut down. These are the jobs on which overtime is the rule rather than the exception but, fortunately, they are rare occurrences. Everything, except safety or absolutely essential repair maintenance, is stopped—and everyone concerned is in conference often enough to keep the necessary labor and material on the job until it is completed. The general superintendent, personally, usually handles the coordination of such jobs, because he is in almost constant touch with maintenance, operations, purchasing; and he calls on the administrative management's assistance whenever this is required or deemed desirable.

Emergencies, either night or day, caused by the failure of equipment which needs the attention of one specialist are handled directly by the operator, with the foreman involved and the assistant superintendent being notified as soon as practicable. Examples of such emergencies are the failure of a gas compressor on the TCC unit, the failure of an electrical circuit, or the failure of a vital instrument. These, also, we are happy to state are rare occurrences.

Salvage

The salvage department is more like an operating unit than a part of the maintenance, except that it is under the maintenance superintendent; and the two men in this section are available at all times for rush maintenance work. This department is staffed by a first-class machinist and a machinist's helper. All material removed on a repair or replacement job is gathered and sent to the salvage department. There it is either cut up and sold as scrap; or it is rebuilt to new specifications, painted for identification, and sold to the warehouse for 50 percent of the new price. When available, rebuilt rather than new equipment or parts must be issued by the warehouse except for certain hazardous locations or uses for which new material is specified. We have not as yet been able to determine the difference in performance or wear of salvaged equipment as compared with new.

The salvage department has an operations unit number, and all material charged against it is handled just as warehouse material is charged to the TCC unit. Whenever specialized work is required from another branch of maintenance, its labor and material are charged to the salvage department. Occasionally, even specialized labor outside of the refinery is required—which, of course, is also properly charged. All of these charges, substracted from the sales to the warehouse and to the scrap dealer, result in a profit or loss to the salvage department. So far it has been a very profitable department, as well as being an important phase of good housekeeping.

One interesting example of the salvage department's work concerns the elevator chain on the TCC unit. As you who are operating TCC units know, a chain has a life of approximately two years. However, it has worn only on one side and, by being rebushed and by having the pins turned, it will have an additional life of approximately two years. We were solicited by a company which had rebuilt several chains for major oil companies, and it requested the job of rebuilding our chain at a cost of $11.40 per link or, with 634 links, at a total cost of $7227.60, plus freight on 8 tons to Texas and back. After a discussion of the job with a representative of the manufacturer of the chain, our salvage department stated that it could show a profit at $7 per link. This estimate was accepted, and the salvage department was allotted one year to do the job without permission to accumulate normal salvage. In less than 7 months the chain was rebuilt at a cost of $6.18 per link, with purchased material accounting for $3.92 per link. It can easily be seen that this represented a saving of more than $3300.

Construction

This paper deals with the maintenance practices in a small refinery; but construction insofar as it is handled by the maintenance department, must be touched upon briefly. Our plant-force construction program is based on the premise that we need trained men to handle abnormal maintenance such as unit shutdowns, cleanouts, and similar. Any construction work which we can do to keep the force busy during the periods of normal maintenance we undertake. Other construction work is

contracted for. Naturally, we would not attempt a major construction job; neither would we take on a minor capital improvement if our maintenance department were far behind in its program. Neither the type of the project nor the dollar value is the deciding factor. As an example, our maintenance department constructed a 60 x 120 masonry warehouse building; yet we contracted for a 20 x 40 masonry fire house.

It becomes advantageous at times to undertake a portion of a project and contract a portion. An example of this was the revamping and the doubling of the capacity of our crude unit. The furnace was erected by The Fluor Corp.; yet the maintenance department erected the prefractionator tower, set in larger pumps from time to time, revamped the lines, and then made the tie-in of old and new equipment during a major shutdown of the unit.

One fairly extensive construction project which the maintenance department undertook was the erection of a vacuum tower, two oxidizing tanks, and the construction of a complete asphalt plant. This was a project which required approximately $30,000 worth of labor.

It is very doubtful, unless a change of policy is instituted, whether we can undertake such types of projects in the near future because of the fact that, although the catalytic cracking unit did not materially affect the manpower required for abnormal maintenance, it has added substantial requirements to normal maintenance.

We have, on an average, 12 special work orders open at all times. Most of these come under the category of construction, and they range from 0 to 99 percent completion. As examples, we list as follows the work orders open as of January 1, 1949: 215, convert south bank of tubes in reformer to viscosity-breaking operation; 224, construct tank foundations and dikes for four 25,000-bbl. tanks; 228, change over and construct power line to back tank farm; and install transfer pump, motor, and necessary piping; 230, build and install lime-slurry injector for TCC unit; 231, build and erect new substation for west bank of transformers; 234, install oxygen recorder at steam plant; 235, install used tank and necessary piping for sulfuric-acid storage at boiler house; 236, lay concrete paving at truck-loading dock; 237, install additional caustic-contact tower at treating plant; 238, install pump and meters at truck-loading rack; 239, build and erect pilot phenol-disposal unit; 240, construct pump houses for three new water wells.

This type of work order must necessarily be scheduled far in advance because, on an average, only three jobs can be completed in a month, and many are open for six months or longer. It would be disastrous to our maintenance program if we were to call for a triple-A priority on more than one or two jobs at the same time.

Inspection and Cleanout

The third division of maintenance, and the division which determines the minimum manpower, is inspection and cleanout. At this point may we state that it is our opinion that a tremendous amount of credit for the safe and excellent maintenance practices of a small refiner should be given to Universal Oil Products Company. Every small refiner who has, or has ever had, a Dubbs cracking unit—and that represents a large number—is aware of the rigid inspection program set up for that unit, and which is maintained on a regular schedule by the inspection department of that organization. One highly qualified metal inspector and, when necessary, additional engineers are sent in to supervise and actually work with the maintenance department during these inspections. Inasmuch as their requirements have always been extremely rigid, yet practical, the result is that both refinery management and the maintenance personnel have become quite conscious of the benefits of thorough inspection and adequate normal and preventive maintenance. This inspection has always been offered as a service, and it costs the refiner nothing over his normal royalty payments. On request, this same service has been extended to crude units and other equipment not under a license agreement. In addition to the inspection, general refinery engineering has been available from this organization for the purpose of assisting a small maintenance department to undertake construction which met rigid specifications. Such type of services has resulted in many of the thoroughly trained UOP personnel accepting responsible permanent positions in these small refineries. In fact, it would be our opinion that there are very few modern small refineries in existence today in this country which do not have one or more UOP-trained men in their personnel; and such men, as a general rule, have substantial weight in establishing maintenance policies. Both our general superintendent and our former assistant superintendent are in this category.

When it appeared that we might select a TCC unit this inspection and engineering service was given very careful consideration, and we were assured by Houdry Process Corporation that it was geared for identical services. We are happy to relate that these people have been giving the same thorough inspection and engineering work on the TCC unit as we formerly obtained for the Dubbs unit, and which we are still obtaining from UOP for the thermal reforming unit.

By the experience gained throughout the years, we have been able to set up, within our own personnel, adequate inspection services and records for the balance of our equipment. Inspection and cleanout shutdowns are exceptionally well planned and scheduled events. Just as soon as experience shows the frequency rate of a unit, it is set up on a yearly schedule. At the present time we have no units which require inspections more frequently than once per year. We have sufficient minor shutdowns of a few hours' duration on the units in order that we may spot-check potential hazards in case there has been a significant change in the composition of the charge stock.

The schedule in effect at present is as follows: crude unit and one 150-hp. boiler, June; TCC unit, cooling tower, and 350-hp. boiler, April; reforming plant, LPG unit, and one 150-hp. boiler, October. The TCC unit had been set up for November and April but, after the first two inspections, it was scheduled yearly. The operations budgets are arranged so that product availability does not upset this schedule.

Planning a Shutdown

At least six weeks before the scheduled shutdown a meeting is held, which brings in all foremen and all operating personnel involved who are not on shift at the time. The agenda of such a meeting follows:

1. The shutdown repair book of the unit is discussed item by item, and a decision is reached on each request. (At each unit we have two maintenance books, one for normal and one for shutdown work.)
2. The last written shutdown list is reviewed item by item, and those which need attention for the coming shutdown are checked.
3. The written inspection report from the preceding inspection is discussed point by point.
4. The list of materials which should have been ordered before the meeting is checked in order to ascertain whether the materials have come in and are on hand, or whether they will be delivered on the date indicated.
5. Determine whether a representative of the manufacturer of any major equipment should be requested to be present during all or part of the shutdown.
6. The definite date and time for shutting down the unit is set.
7. The length of the shutdown is discussed and tentatively set.

A secretary is present at this meeting to record each decision made and,

when requested, to take a report of any discussion. As soon as possible after this meeting, a complete shutdown work list, separating the work by departmental headings, is prepared by the general superintendent, and copies are sent to all foremen and posted on the unit bulletin board. From that point on, the maintenance superintendent is responsible for working closely with the purchasing agent to assure that all material is on the job on time. One week before the shutdown another general meeting is held, and the maintenance superintendent outlines the work schedule; this schedule gives an estimated man-hour breakdown of the various jobs and the procedure for attack, so that all work will end at approximately the same time. Naturally, such an estimate can only be a guide, and it must be juggled constantly after the shutdown begins. Lists have been prepared dividing all personnel, except operating, into two 12-hour shifts, 6 days per week. The operating men remain on their regular 8-hour shift, but they act as supervising foremen over a particular section of the unit. After this meeting the final job and assignment lists are typed and distributed; and, during the week, detailed checks are made of material, special cleanout equipment, and similar.

First Turnaround

We admit frankly that we were quite anxious concerning the first turnaround of the TCC unit. We had read of records being made turning around catalytic cracking plants in 21 days with only 360 men. On this basis, it would appear that we could run for six months and clean out for six months. Our maintenance superintendent had spent a lot of his time on the unit during construction, and he consistently insisted that he could take care of the turnaround with his plant force in less than three weeks. The job was completed in 264 hours with an expenditure of a total of 5053 man-hours; 501 hours, or almost 10 percent, of the turnaround labor was accounted for by the necessity of replacing carbon-steel lines with 4- to 6-percent chrome around the tar separator. These lines had been in service for several years on the Dubbs unit, and probably should have been replaced during the tie-in work of the construction project. The details of this first turnaround were published in the PETROLEUM REFINER, March, 1948.

Outside Assistance

In an inspection of the crude unit, LPG plant, treating plant, and miscellaneous equipment, we require no outside assistance. We have a chemical engineer who normally spends one-half of his time on supervising and working on daily refinery yields, and the other half as combustion engineer. This man is made available during turnarounds, and he works in the capacity of metal-inspection engineer. From having worked with Universal Oil Products Company and Houdry Process Corporation metal inspectors, he has become proficient in that capacity. He follows the established procedure of hammer-testing, drilling, and calipering through the open ends of pipes, tubes, and manways. As soon as possible after the turnaround he prepares an extensive report which lists all measurements, work done during shutdown as a result of the inspection, and a schedule of work to be done at the next shutdown. He also keeps a complete record of changes made between planned turnarounds.

In an inspection of a boiler, we request a man from the insurance company; and he advises on the work, approves the boiler, and later submits a complete report on the inspection.

In an inspection of the thermal reformer, we schedule a qualified UOP inspector, and he supervises the job generally and takes all measurements personally with the assistance of our inspector. We are later supplied by UOP with a complete report of the inspection part of the turnaround, which report shows the work completed on recommendation of the inspector and the work to be done during the next shutdown.

Company Inspectors

In an inspection of the TCC unit, Houdry Process Corporation sends a qualified metal inspector and two engineers. The inspector supervises the inspection work, and personally takes all measurements with the assistance of our inspector. The two engineers, with the assistance of helpers provided by us, go throughout the entire unit for the purpose of making visual inspections and comparing the results with those of the last written report. Within approximately two months we receive six copies of a very detailed report of the inspection. To give an idea of this report, we list the table of contents of the third inspection report on the turnaround of April, 1949, as follows:

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In addition to the Houdry personnel, we request the following outside technical assistance, which is always supplied:

An engineer from one company to inspect and make recommendations concerning the catalyst elevator; approximate time required, 4 days. (On the third inspection, this engineer supervised the removal of the old chain and the installation of a new chain and head shaft. He was on hand for almost two weeks.)

An engineer from another company to inspect and make recommendations concerning the gas-driven gas compressors (2 days).

An engineer from a third company to inspect condition of the turbine which drives the main water-supply pump (1 day).

Also, occasional requests for representatives of the company which manufactures equipment which might have been giving trouble or excessive maintenance during the run.

For several years, on any unit shutdown, we worked seven days a week, with no time off until the unit was on-stream. For the past two years we have been scheduling our turnarounds on a six-day week, and we find that we get a faster and better job. Even though we pay double time for the seventh day, the men are almost unanimously in favor of the day of rest. Of course, the operators continue on a seven-day week, as their day off is on a regular schedule, but these men are used very profitably on Sunday in general cleanup work around the unit.

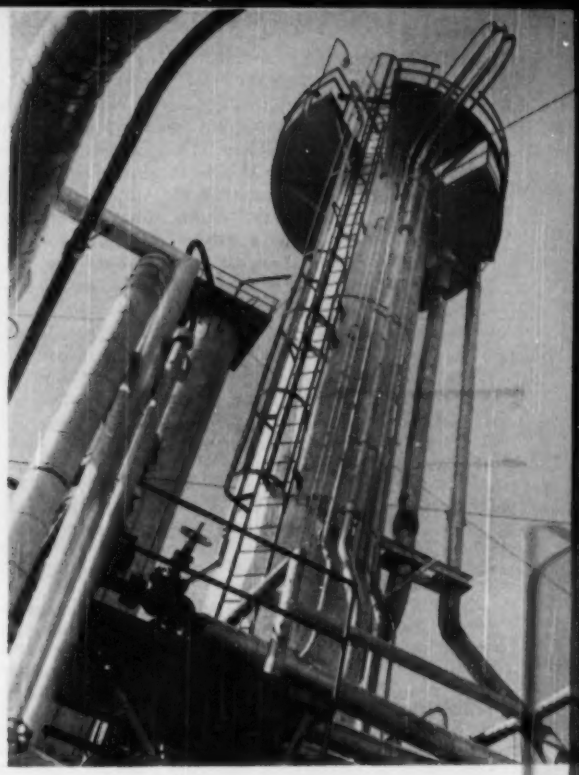
We hope that some of you will be able to gain some ideas from our more or less detailed statement of our maintenance practices, inasmuch as a great many of them were brought about by adoption of the ideas of others.

We desire to thank all of the companies mentioned for their part in assisting us to maintain our refinery in first-class condition. Others, too numerous to mention, also are of great help. The main credit, however, must be given to our most capable and most loyal refinery personnel.

Report to the API

Investigation of Sulfur In Motor Fuels-- Effects on Engine Operation

R. E. JEFFREY, JR., J. B. DUCKWORTH
and E. J. GAY



THE increasing utilization of high-sulfur crudes, for the purpose of supplementing crude supply during and following World War II, has focused attention on the possible effect of sulfur in motor fuel on engine wear, corrosion, deposits, and other factors affecting engine life. Extensive work on these problems had not been conducted since the early 1920's largely because, since that time, improvements in engine design — particularly the almost universal use of crankcase ventilation and thermostatic control of engine jacket temperature—have reduced the incidence of trouble from sulfur in motor gasoline to a point where it is not currently recognized as an acute problem. This is further borne out by the satisfactory operational experience on the West Coast of the United States where moderately high-sulfur levels in gasoline have been used for many years. Also certain surveys made prior to the war did not tie increased sales of pertinent engine and exhaust-system parts to the area where higher-sulfur fuels were sold. However, it was recognized that adequate up-to-date technical information was not currently available; and, at a meeting of the executive committee of the Coordinating Research Council board of directors, the petroleum members proposed that factual data on this subject would be desirable. The problem was assigned to the Motor Fuels Division of the Coordinating Fuel Research Committee, September 17, 1945, and a group on sulfur in motor gasoline was organized to handle the project.

***PRESENTED HERE** are results of 4½ years of cooperative work carried out to investigate the effects of sulfur in motor gasoline on engine operation. The American Petroleum Institute and the Society of Automotive Engineers jointly supported this test program, under the sponsorship of the Coordinating Research Council, Inc. A large number of companies—including the automotive and petroleum industries, and several fleet owners—participated directly in laboratory and field service tests; 62 vehicles completed service tests at seven test sites wherein the effect of two motor-gasoline sulfur levels—roughly 0.10 and 0.25 per cent—on engine wear and cleanliness were compared. A total of 1½ million test miles—ranging from light-duty–intermittent to heavy-duty–continuous—were accumulated in service. The scope of the program was limited to the technical aspects of sulfur in motor gasoline, and did not include an evaluation of economic considerations which are a part of the broad over-all problem. The test data show that the influence of high gasoline sulfur content may vary from a pronounced effect on cylinder and ring wear, at some operating conditions, to no effect under continuous operating conditions at normal engine-operating temperatures. The results of these controlled tests, to a considerable extent, do not check general field experience even in those areas where high-sulfur gasolines have been widely used. So the engine manufacturer and petroleum refiner may wish to do further work with their own products—using their own test facilities, following the several avenues of investigation which are open to both.*

The discussion was before the Motor Fuels session during the recent Mid-Year meeting of the API Division of Refining at Cleveland.

Mr. Jeffrey is with Shell Oil Company, San Francisco; Mr. Duckworth, Standard Oil Company (Indiana), Whiting; whereas Mr. Gay is a Detroit consultant.

Laboratory Engine Tests

1) Because of the complexity of the over-all problem it was decided to conduct relatively inexpensive laboratory dynamometer tests. These tests would serve to indicate the conditions under

which sulfur might affect engine performance and, further, would aid in the selection of fuels for field service tests which were to be run at a later date. Dynamometer tests consisted of various single-cylinder and multi-cylinder engine tests, run under a wide variety of test conditions, ranging from high to low operating temperatures and from continuous to cyclic or intermittent operation.

2) Approximately 100 laboratory engine tests, covering at least 3,800 test hours, when compiled and analyzed showed that cylinder-bore and piston-ring wear increased with higher sulfur content of the gasoline. The laboratory test panel, recognizing that normal field operating conditions and geographic location might produce results differing from laboratory dynamometer tests, recommended the adoption of a full-scale field service test.

3) The laboratory test panel recommended field service tests using a fuel containing 0.25 to 0.30 percent sulfur for the higher-sulfur value, and a fuel of less than 0.10 percent for the lower-sulfur value. This range was chosen so as to bracket commercial-gasoline sulfur contents which would normally be expected to be distributed in this country over the next several years. At present most commercial gasolines are substantially below this higher value. The panel further recommended that the fuel of lower sulfur value used for tests on the West Coast could be 0.15 percent or less.

Engine Field Service Tests

1) The recommendation of the laboratory tests panel was accepted, and in the summer of 1947 a field test panel was organized to initiate a practical field test program. The CFR-MFD group on sulfur in motor gasoline recognized that any one field service-test program would not furnish a complete and final appraisal of the problem. However, these tests would help sort the problem into definite categories wherein sulfur in gasoline may or may not be a problem, and they would provide guidance for future work.

2) After conferences with many fleet owners in various parts of the country, seven fleets (62 vehicles) were selected. These fleets represented a wide variety of equipment, from passenger cars to heavy trucks, in services ranging from light-duty city-delivery to over-the-road heavy-duty. The test locations covered a considerable range of ambient air temperatures. A more complete account of each fleet is shown in Table 1.

3) During early conferences on the conduct of the field test program, representatives of Ford, Chevrolet, and Chrysler agreed to supply new test engines for the fleets using their make of vehicle. They also agreed to undertake the task of measuring these same engines after their removal at the end of the test. The American Petroleum Institute agreed to assume an estimated expense of approximately $50,000 for the direct cost of the test to the Coordinating Research Council, Inc. The oil companies were to furnish project engineers and other personnel for the technical surveillance of the test vehicles.

4) Original plans called for the supply to all fleets of a naturally-occurring high-sulfur gasoline. In selecting the test fleets, it became apparent that locations ranging from central Pennsylvania to the West Coast would necessitate shipping from the West Coast (and storing) approximately 200,000 gallons of gasoline. This presented a difficult problem of supply, as well as an item of considerable expense. As a result, consideration was given to the work of the laboratory test panel on various sulfur compounds. This work showed that a number of sulfur compounds, when added to a given fuel, gave approximately the same results from the standpoint of cylinder-bore and piston-ring wear as was obtained with fuels containing an equal amount of natural sulfur. A further check test was made by one of the oil-company research laboratories, using disulfide oil as a means of raising the sulfur content of the test gasoline. This test confirmed the earlier results and, upon the recommendation of the fuels panel, the sulfur group agreed to use disulfide oil as a means of obtaining higher sulfur values in the gasoline.

5) The gasoline normally furnished the fleet was used as the control fuel. To this fuel a sufficient amount of disulfide oil was added to obtain the desired level of 0.25 to 0.30 per cent sulfur. This gave the additional advan-

TABLE 1

Fleet No. Vehicle Type	Test Location	No. of Vehicles on Test	Type of Service	Total Average Test Miles per Vehicle	Sulfur Content (Percent by Weight)	Condition of Engine at Start of Test	Lowest Mean Minimum Temp. (Deg. F.)	Highest Mean Maximum Temp. (Deg. F.)	Average Miles per Day	Engine Starts per Day	Idle Periods Per Day	Oil Type and SAE Grade
Fleet 1 Vehicle A	Middle Atlantic state	8	Heavy-duty	L 30860 H 39855	L 0.114 H 0.256	Rebuilt	16.7	85.3	114	1	1,140	Heavy-duty 30
Fleet 2 Vehicle B	Central Midwest	8	Heavy-duty	L 87670 H 95536	L 0.091 H 0.281	New	19.3	88.3	240	7	5	Premium 30
Fleet 3 Vehicle C	Large Midwest city	8	Light-duty intermittent	L 11139 H 10730	L 0.083 H 0.267	New	10.0	88.3	36	80	0	Premium 30 and 40
Fleet 4 Vehicle D	Large Midwest city	8	Light-duty intermittent	L 5443 H 5067	L 0.066 H 0.267	New	10.0	88.3	15	15	7	Regular 10 and 20
Fleet 5 Vehicle E	Large Midwest city	4	Medium-duty	L 18783 H 16168	L 0.056 H 0.269	New	10.0	88.3	52	13	58	Regular 30
Vehicle E	Large Midwest city	4	Intermittent	L 25270 H 20314	L 0.056 H 0.269	New	10.0	88.3	52	13	58	Heavy-duty 30
Fleet 6 Vehicle D	Large West Coast city	6	Light-duty	L 3134 H 3450	L 0.140 H 0.290	New	38.8	67.7	10	11	5	Regular 20
Vehicle G	Large West Coast city	6	Intermittent	L 2912 H 2908	L 0.140 H 0.290	New	38.8	67.7	10	11	5	Regular 20
Fleet 7 Vehicle F	Southwest Coast	2	Medium-duty	L 14304 H 15276	L 0.132 H 0.264	New or rebuilt	37.9	84.2	52	7	1	Heavy-duty 30
Vehicle H	Southwest Coast	2	Light-duty intermittent	L 6901 H 8829	L 0.132 H 0.264	New or rebuilt	37.9	84.2	18	19	2	Heavy-duty 30
Vehicle HA	Southwest Coast	2	Medium-duty	L 14065 H 16336	L 0.132 H 0.264	New or rebuilt	37.9	84.2	38	8	2	Heavy-duty 30
Vehicle I	Southwest Coast	2	Light-duty intermittent	L 9011 H 4579	L 0.132 H 0.264	New or rebuilt	37.9	84.2	13	11	3	Premium 30
Vehicle J	Southwest Coast	2	Intermittent	L 9965 H 8572	L 0.132 H 0.264	New or rebuilt	37.9	84.2	34	12	1	Premium 30

tage of having the base-stock tetraethyllead content and octane number (prior to the addition of the disulfide oil) the same for both fuels. There was one exception to this procedure: One West Coast fleet was provided with a naturally-occurring high-sulfur gasoline. This was done to give a direct comparison with another fleet in the Midwest, in similar service, but using gasoline with disulfide oil added. In most fleets extra tankage and another dispensing pump were provided to handle the special fuel.

6) No attempt was made to place special crankcase lubricating oils in these various fleets, because it was felt that variables other than the sulfur content of the gasoline should not be introduced at this time. It was also not desirable to risk the psychological problems which might arise, and which could be blamed on the change of oil type. Each fleet operator was asked to agree to continue using the same brand of oil throughout the year's test duration. In one fleet two types of oil were already in use, and in that case the sulfur-test vehicles were split half and half between the two oils: One oil was a regular-grade; the other oil was a heavy-duty grade.

7) As shown in Table 1, new engines were installed in four fleets. In the fifth fleet the trucks were new at the start of the tests, so that these engines could be considered as new engines. The engines from the two remaining fleets were disassembled, rebuilt, and measured before the start of the test. New mufflers were installed on all vehicles. A project engineer from the oil company supplying the fuel was assigned to each test fleet. It was his duty to provide technical surveillance of the test, following procedures set down by the field test panel. No attempt was made to change the operator's methods of running his fleet, as this would then take the test out of the category of a practical field operation. This procedure developed certain disadvantages, which will be discussed later in this paper.

8) Periodic fuel and used-oil samples were checked by the project engineer's parent company. Also, used-oil samples were sent to the Shell laboratories on the West Coast for a reference check of all oils by one laboratory. Just prior to the start of the tests the engine-sludge and varnish group of the Motor Fuels Division suggested that this sulfur field-test program presented an excellent opportunity to obtain comparative data between laboratory and field tests on engine deposits. Accordingly, arrangements were made to send sufficient supplies of gasoline and lubricating oils to several laboratories for FL-2 and L-4 tests.

9) Actual field tests started with some vehicles late in October, 1947. All tests were in operation by February, 1948, and were completed by the late spring, 1949. Prior to the end of the tests, two new panels within the sulfur group had been formed. One of these was the engine-inspection panel, and the other was the engine-sludge and varnish-rating panel. Inspection procedures were set up by each panel; and these procedures were, in general, followed for each fleet. All engines (from four fleets) furnished by Chevrolet, Chrysler, and Ford were removed from the test vehicles, and shipped back to the engineering departments of these companies for inspection and measurements. The engines from the other three fleets were removed and inspected at or near the fleet location. Engineers from the manufacturers were able to view all engines except one fleet on the West Coast. In most cases at least two men from the engine-inspection panel were able to view all of the test engines. Through a fortunate arrangement all fleets, with the exception of one West Coast fleet, had at least one man from the sludge and varnish panel available to help start the rating of the engines. All the engines which were sent back to Detroit for inspection and measurements were thoroughly rated for sludge and varnish by the same two men in order to establish uniformity in standards of rating. Engines which came back to the manufacturer were measured and rated in accordance with standards of accuracy normally used by the manufacturer. Likewise, engines examined in the field were carefully measured by skilled personnel. In order to achieve more complete coordination of data, the project engineer from each of the fleets using Chrysler, Ford, and Chevrolet engines was present at the respective manufacturer's plant during the time the engines were being inspected and measured.

10) The National Research Laboratories of Canada cooperated with the Coordinating Research Council, Inc., on this problem; and, during 1946-48, carried out a service test at the Canadian Army Proving Grounds, using military vehicles. Operation under stop-and-go driving conditions produced no significant difference between fuels containing approximately 0.05 and 0.30 percent sulfur. The cylinder-bore wear observed in the Canadian tests, however, did not exceed 0.001 inch after 2300 miles operation on either low or high-sulfur gasoline.

11) After the inspections had been completed, the entire file of data on the seven test fleets was turned over to a seven-man analysis panel. This panel was charged with the responsibility of preparing the final report on the tests for the CFR committee. It was the duty of this panel to sift out the essential information, and to present this information in report form. The report was prepared, and has been approved, by the Coordinating Fuel and Equipment Research Committee. It is now available from the American Petroleum Institute and the Society of Automotive Engineers, under the title "Sulfur in Motor Gasoline, January, 1950."

Results

1) Sixty-two vehicles completed field service tests at seven test sites during

the period October, 1947, to June, 1949. Two motor-gasoline sulfur levels of 0.056 to 0.140 percent and 0.25 to 0.30 percent were compared in regard to engine wear and cleanliness. A total of 1,501,698 test miles was accumulated in service, ranging from light-duty to intermittent-duty to continuous heavy-duty. From these tests the following results may be of major interest:

a) Twenty vehicles in three fleets—representing four types of engines used in a heavy-duty or moderate-duty continuous service, such as over-the-road trucks, urban bus service, or medium bus service—showed essentially no difference in wear for gasoline sulfur content within the limits prescribed by the test procedure and as shown in Table 2. No inter-city bus-service test was conducted; but, based on the results of the over-the-road truck service, it may be reasonable to assume that the same result would apply.

b) Thirty-four vehicles in four fleets—representing five types of engines, in light-duty intermittent service, with many stops and starts or idle periods per day—produced consistent differences in wear within the sulfur limits prescribed by the test procedure and as shown in Table 3. Typical services for these vehicles are city delivery routes such as bread and parcel delivery, light repair or trouble shooter trucks for gas, telephone and electric utilities, supervisor's cars, etc.

c) Eight vehicles in one fleet—engaged in typical medium-duty intermittent-delivery service, door-to-door—showed a marked increase in wear. In this fleet, wherein the low-sulfur fuel was 0.056 percent and the high-sulfur fuel 0.269 percent, and wherein a regular-grade oil was used, wear for the high-sulfur engines had progressed to the level of requiring an overhaul (see Table 4).

The use of a heavy-duty crankcase oil (REO-37) in this fleet produced a 50-percent reduction in cylinder wear in vehicles operated on the low-sulfur fuel, but did not appreciably reduce cylinder wear in the high-sulfur vehicles. Cylinder wear for both oils and the high-sulfur fuel was 0.005 to 0.006 inch. However, wear, when using the (REO-29) regular oil and the low-sulfur fuel, was three thousandths (0.003 inches). With the low-sulfur fuel and the (REO-37) heavy-duty oil, the wear was about one and one-half thousandths (0.0015 inch), or approximately one-half the amount of wear obtained with the regular oil.

d) In the same fleet (No. 5), wherein a heavy-duty oil (REO-37) was compared with a regular oil (REO-29), it was noted that crankcase deposits and oil ring-groove deposits were reduced for both high and low-sulfur vehicles by the heavy-duty oil.

e) In a comparison of one fleet (West Coast), using a naturally-occurring high-sulfur gasoline against one other fleet (a Midwest city) using the same vehicles in the same type of service and using a gasoline with disulfide oil added, wear results were substantially equivalent. This confirms previous tests made during the laboratory test phase.

f) Valve operation and valve life were not adversely affected by high-sulfur fuel. Three low-sulfur vehicles in one heavy-duty fleet were overhauled during the test period because of sticking valves.

g) Muffler life and exhaust-system corrosion were not adversely affected by high-sulfur fuel.

h) In all but one of the seven fleets there was little or no effect of high sulfur on engine varnish and sludge deposits. This other fleet showed differences of 7 to 10 points (out of a possible 100) in favor of the low-sulfur fuel.

i) Laboratory dynamometer FL-2 tests qualitatively reflect the effects of high sulfur on cylinder and ring wear in light-duty intermittent service, but L-4 tests do not reflect wear in medium to heavy-duty service.

j) Based on two fleets in light-duty-intermittent service, and within the range of atmospheric conditions and temperatures prevailing during the test period (the actual mean minimum air temperatures were 18° and 45° F.), there was no apparent influence of ambient air temperatures or geographic location on differences in engine wear between high and low-sulfur fuels.

k) The test data do not permit separation of the effect of engine design on the difference in wear due to sulfur because of the influence of type of service or duty. In one fleet, where two types of vehicles were employed, the percentages of increase in wear with high-sulfur fuel were not significantly different. However, the absolute rate of wear in one type of vehicle was approximately twice as high as that in the other with both high and low-sulfur fuels. The maximum difference in bore wear was 0.0016 inch, and the test mileage was 2900 to 3400.

TABLE 2

Summary of Engine-Cylinder and Ring Wear

FLEET	Vehicle Type	Test Fuels (Percent by Weight of Sulfur)		Cylinder-Bore Wear at Top Ring Corrected for Mileage[1] (Inches)		Top-Ring Wear Corrected for Mileage[1] (Inches)		Increase in Wear of High-Sulfur Over Low-Sulfur Corrected for Mileage[2] (Percent)	
		Low-Sulfur	High-Sulfur	Low-Sulfur	High-Sulfur	Low-Sulfur	High-Sulfur	Bore	Rings
1	A	0.114	0.256	0.0044	0.0038	0.0044	0.0050	−14	14
2	B	0.091	0.281	0.00168	0.00137	0.0097	0.00963	−18	−2
7	F	0.132	0.264	0.0040	0.0044	0.0192	0.0203	10	6
7	HA	0.132	0.264	0.0090	0.0051	0.0278	0.0299	−43	7
7	J	0.132	0.264	0.0023	0.0023	0.021	0.027	0	29

[1] Average actual wear divided by average actual miles and multiplied by 10,000 to give 10,000-mile units.

[2] Percent change = (wear high-sulfur (per unit mile) − wear low-sulfur (per unit mile)) / wear low-sulfur (per unit mile)

TABLE 3

Summary of Engine-Cylinder and Ring Wear

FLEET	Vehicle Type	Test Fuels (Percent by Weight of Sulfur)		Cylinder-Bore Wear at Top Ring Corrected for Mileage[1] (Inches)		Top-Ring Wear Corrected for Mileage[1] (Inches)		Increase in Wear of High-Sulfur Over Low-Sulfur Corrected for Mileage[2] (Percent)	
		Low-Sulfur	High-Sulfur	Low-Sulfur	High-Sulfur	Low-Sulfur	High-Sulfur	Bore	Rings
3	C	0.063	0.267	0.0021	0.0042	0.0292	0.0490	110	68
4	D	0.066	0.267	0.0015	0.00296	0.0093	0.0190	80	105
6	D	0.140	0.290	0.0032	0.0056	0.0201	0.0313	75	56
6	G	0.140	0.290	0.0065	0.0122	0.0614	0.0804	88	31
7	H	0.132	0.264	0.0107	0.0177	0.0478	0.0688	65	44
7	I	0.132	0.264	0.0054	0.0120	0.0411	0.0786	123	92

[1] Average actual wear divided by average actual miles and multiplied by 10,000 to give 10,000-mile units.

[2] Percent change = (wear high-sulfur (per unit mile) − wear low-sulfur (per unit mile)) / wear low-sulfur (per unit mile)

TABLE 4

Summary of Engine-Cylinder and Ring Wear

FLEET	Vehicle Type	Test Fuels (Percent by Weight of Sulfur)		Cylinder-Bore Wear at Top Ring Corrected for Mileage[1] (Inches)		Top-Ring Wear Corrected for Mileage[1] (Inches)		Increase in Wear of High-Sulfur Over Low-Sulfur Corrected for Mileage[2] (Percent)	
		Low-Sulfur	High-Sulfur	Low-Sulfur	High-Sulfur	Low-Sulfur	High-Sulfur	Bore	Rings
5 (Regular Oil)	E	0.056	0.269	0.0030	0.0063	0.0126	0.0239	117	90
5 (Heavy-Duty Oil)	E	0.056	0.269	0.0013	0.0052	0.0082	0.0173	300	111

[1] Average actual wear divided by average actual miles and multiplied by 10,000 to give 10,000-mile units.

[2] Percent change = (wear high-sulfur (per unit mile) − wear low-sulfur (per unit mile)) / wear low-sulfur (per unit mile)

Application of Experience to Any Future Field Service Tests

1) This field test program has shown that it is possible to conduct wide-scale field tests on a cooperative basis. The practical aspects of these tests are of real value; because, as yet, there ap-

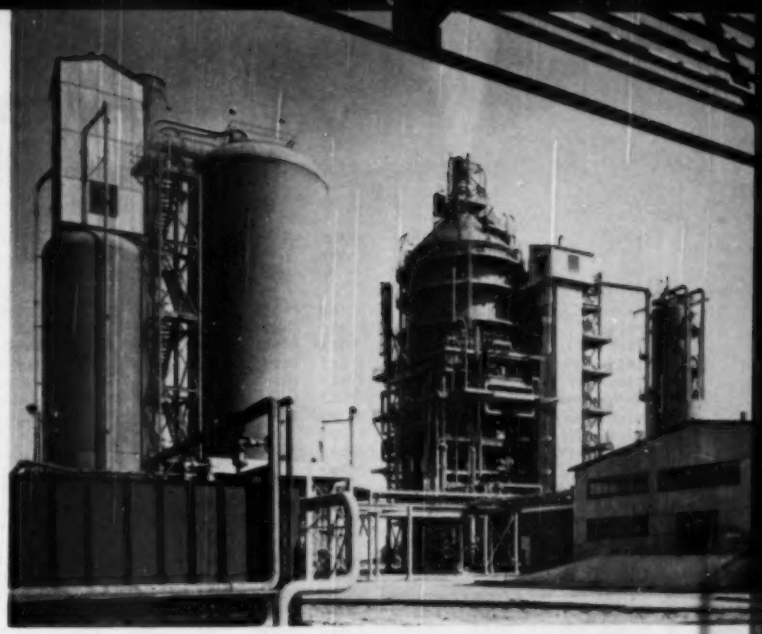
pears to be no good substitute for letting the engine say what it likes; nor is there an electronic device which duplicates all the variables of a driver's foot on the accelerator pedal. Lessons were learned which would bear repeating herein.

2) The oil-consumption figures obtained for many of the fleets were not adequate. It is not practical for an operator carefully to drain and weigh the oil at each drain period and also to weigh the new fill of oil. It has been suggested that calibrated dip sticks be used in any future tests. Maintenance crews would then be instructed about over-filling at a drain period and when adding makeup oil. It would also be necessary to request the fleet to add oil in order to bring the crankcase to the "full" mark before the oil was drained. In this way a reasonably accurate figure of total oil added between drain periods would be obtained. The fleet would have to be reimbursed for the extra oil used at the drain period, but this amount would be small in return for the improved accuracy of the data.

3) It still appears that it is best not to have an engineer on the property at all times. When this is done, the day-to-day procedures of the fleet are likely to be influenced and the final results may not be typical of the fleet's normal operation. Regardless of how well the program is outlined, it still appears that at the start of a test every fleet, project engineer, and manufacturer's representative involved should be visited by the test group coordinator. This permits a thorough discussion of all phases of the test, and avoids mistakes and incorrect impressions before they occur.

4) In any further field tests involving wear measurements, consideration should be given to the measurement of top-cylinder bore sizes and ring gaps (or weights) of new engines before the test is started. Other measurements on new engines are not necessary. The cost of the test will be somewhat more, but the precision of the test will be improved. Older engines being rebuilt for test purposes will, of course, have necessary measurements taken.

5) Mass field-test data properly collected are always of greatest value. If costs permit, more fleets and more vehicles should be used than were used in this test. In those fleets wherein mileages accumulated in one year are likely to be very low, it might be well to set up two duplicate groups of test vehicles. One group would be disassembled and measured at the end of one year; the other group would continue through to the end of the second year.



Fleet Owner's Contribution

1) This paper would not be complete without giving credit to the contribution of the fleet owners toward making the test possible. It is unfortunate that coding of the report prevents giving their names. Beside those fleets actually used for the test, there were several others which indicated willingness to permit use of their equipment.

2) Without the help of these fleets, it is doubtful that such a wide-scale fleet test could be run. The direct outlay in dollars for this test was slightly under 4 cents per mile. It is questionable that 30 cents per mile would have covered the costs of vehicles, drivers, fuel, oil, and maintenance which would have been needed.

3) Work of this type builds respect and understanding. The fleet operator is brought to realize that his suppliers are on the alert to keep him out of trouble and to improve their product. All fleets have offered their equipment for further test programs.

Summation

1) The test data reported show that the influence of up to 0.3 percent sulfur in gasoline, as compared to gasolines of 0.1 percent sulfur and lower, may vary from a pronounced effect on cylinder and ring wear, under some operating conditions, to no effect under continuous operation at normal engine temperature. This increased wear, to a considerable extent, does not check general field-service experience, even in the areas where high-sulfur gasolines have been widely used.

2) It is the opinion of the authors of this paper that there is ample material for study in the CRC report on sulfur in motor gasoline. The engine manufacturer and petroleum refiner may wish to do further work with their own products—using their own test facilities, following the several avenues of investigation which are open to both. This is as it should be, inasmuch as the problem is now theirs to establish competitive and economic boundaries. There may come a time when all concerned might like to conduct a further cooperative field test.

3) A full-scale cooperative field test —involving several hundred people and a considerable expenditure of money and material—has been completed. Each group, company, or person who was in any way related to the test program fulfilled all of the obligations which they had agreed to undertake. In many cases the personal contribution of individuals was far above what one might normally expect.

4) There were differences of opinion, as one might expect from a group of technical people; however, general agreement was always possible. No two groups are more competitive within their respective industries than are the automobile and petroleum industries. Their ability to work together on this common problem is a tribute to their desire to serve their customers well!

ACKNOWLEDGMENT

This report represents the joint efforts of a great many people within the petroleum and automotive industries, as well as several fleet owners who participated in these tests. The authors wish to express their appreciation for the splendid cooperation and the many helpful suggestions which have been given so freely by all those associated with the work, and which have been essential to bringing the project to a successful conclusion.

PHYSICAL CONSTANTS

	Name	Mol. Wt.	M.Pt. F	BOILING POINTS °F. AT 20 mm Hg 100 mm Hg†	14.7 psia	100 psia	500 psia	Vapor Press @ 100F psia	LIQUID DENSITY Sp. Gr. 60/60F	Deg. API	lb/gal 60F
PARAFFINS											
1	Methane	16.0	−296	−295†	−259	−204	−131	—	0.241①	441①	2.01①
2	Ethane	30.1	−298	−214	−128	−46	62	—	0.378②	243②	3.15③
3	Propane	44.1	−306	−150	−44	56	186	188.7	0.508③	147②	4.23③
4	Butane (iso)	58.1	−255	−108	11	122	266	71.0	0.563③	120②	4.70②
5	Butane (N)	58.1	−217	−92	31	146	295	52.0	0.584③	110.8②	4.87②
6	Pentane (neo) 2,2-dimethyl propane	72.1	+2	—	49	166	—	38.0	0.601②	103.9②	5.01②
7	Pentane (iso) 2-methylbutane	72.1	−256	−53	82	209	—	20.4	0.625	94.9	5.21
8	Pentane (N)	72.1	−201	−40	97	224	—	15.6	0.631	92.7	5.26
9	Hexane (neo) 2,2-dimethylbutane	86.2	−148	−24	122	253	—	9.9	0.654	84.9	5.45
10	Hexane 2,3-dimethylbutane	86.2	−199	−12	136	268	—	7.4	0.666	81.0	5.56
11	Hexane (iso) 2-methylpentane	86.2	−245	−7	140	274	—	6.8	0.658	83.5	5.48
12	Hexane 3-methylpentane	86.2	180	−3	146	282	—	6.1	0.669	80.0	5.58
13	Hexane (N)	86.2	−140	+6	156	294	—	5.0	0.664	81.6	5.54
14	Heptane 2,2,3-dimethylbutane	100.2	−13	19	178	319	—	3.4	0.694	72.4	5.79
15	Heptane (iso) 2-methylhexane	100.2	−181	36	194	337	—	2.3	0.683	75.7	5.69
16	Heptane (N)	100.2	−131	49	209	355	—	1.6	0.688	74.2	5.74
17	Octane (iso) ⑤2,2,4-trimethylpentane	114.2	−161	45	211	357	—	1.7	0.696	71.9	5.80
18	Octane 2,5-dimethylhexane	114.2	−132	63	228	378	—	1.1	0.698	71.2	5.82
19	Octane (N)	114.2	−70	89	258	412	—	0.5	0.707	68.6	5.89
20	Nonane (N)	128.2	−64	126	303	467	—	0.2	0.722	64.5	6.02
21	Decane (N)	142.3	−21	161	345	514	—	0.1	0.734	61.3	6.12
NAPHTHENES											
22	Cyclopropane	42.1	−198	—	−27	75	209	150	0.720@ −110°F		—
23	Cyclobutane	56.1	−58	—	55	124	330	35	0.690③	73.5②	5.75③
24	Cyclopentane	70.1	−137	−22	121	251	—	9.6	0.750	57.2	6.26
25	Cyclohexane	84.2	44	78†	177	318	—	3.2	0.783	49.2	6.53
OLEFINS											
26	Ethylene Ethene	28.1	−272③	−237	−155	−81	18	—	0.41①	214①	3.41①
27	Propylene Propene	42.1	−301③	−157	−54	44	170	221	0.522②	139.6②	4.35③
28	Butylene (iso) 2-methylpropene	56.1	−221	−100	20	130	280	63	0.600②	104.3③	5.00②
29	Butylene (α) Butene-1	56.1	−302③	−99	21	131	281	62	0.601②	103.9②	5.01③
30	Butylene (β) Butene-2	56.1	−197	—	34	146	300	51	0.616	98.3	5.13
31	Amylene (N) Pentene-1	70.1	−265	11†	86	222	—	16	0.646	87.5	5.39
DIOLEFINS											
32	Butadiene-1,3	54.1	−164	—	24	136	286	58	0.627③	94.2③	5.23③
33	Butadiene-1,2	54.1	−213	—	50	167	—	54	0.658③	83.5③	5.49②
ACETYLENE											
34	Acetylene Ethyne	26.0	−114	—	−119④	−35	72	—	0.621 @ Boiling Point		
AROMATICS											
35	Benzene	78.1	42	79†	176	315	—	3.4	0.885	28.4	7.38
36	Toluene Methylbenzene	92.1	−139	65	231	381	—	1.0	0.872	30.8	7.27
MISCELLANEOUS SOLVENTS											
37	Acetone Propanone	58.1	−138	—	134	—	—	—	0.786	48.5	6.54
38	Methyl-ethyl Ketone Butanone	72.1	−123	29	175	—	—	—	0.809	43.4	6.74
39	Methyl alcohol Methanol	32.0	−144	—	148	—	—	—	0.796	46.3	6.63
40	Ethyl alcohol Ethanol	46.1	−170	—	173	—	—	—	0.794	46.7	6.61
41	Futural	96.1	−34	138	323	—	—	—	1.164	−10.0	9.70
42	Phenol	94.1	108	—	359	—	—	—	1.071 @ 77° F (Solid)		
43	Water	18.0	32	72	212	328	467	—	1.000	10.	8.33
MISCELLANEOUS GASES											
44	Air	29.0⑨	—	—	—	—	—	—	—	—	—
45	Ammonia	17.0	−108③	—	−28	56	161	—	0.682 @ Boiling Point		
46	Carbon Monoxide	28.0	−341	—	−313	—	—	—	0.814 @ −320° F		
47	Carbon Dioxide	44.0	—	(Sublimes at −109)			—	—	(Sublimes at −109°F)		
48	Chlorine	70.9	−151	—	−30	—	—	—	1.56 @ Boiling Point		
49	Hydrogen	2.016	−434	—	−423	—	—	—	0.07 @ Boiling Point		
50	Hydrogen Sulfide	34.1	−117	—	−76	—	—	—	0.79		
51	Nitrogen	28.0	−346	—	−320	—	—	—	0.808 @ Boiling Point		
52	Oxygen	32.0	−361	—	−297	—	—	—	1.14 @ Boiling Point		
53	Sulfur Dioxide	64.1	−99	—	14	110	232	—	1.460 @ Boiling Point		

① Values extrapolated beyond the critical point.
② Liquid at saturation pressure.
③ Triple point.
④ Sublimation point.
⑤ Research method.

(Revised October, 1949)

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Useful in Petroleum Refining

Sp. Gr. Air=1.0	VAPOR DENSITY: Lb/M cu ft 60F 14.73 psia	VAPOR DENSITY: Cu ft Vapor per gal liquid 60F 14.73 psia	CRITICAL CONSTANTS: Temp F	CRITICAL CONSTANTS: Press psia	CRITICAL CONSTANTS: Density Gm/c.c.	Lat. heat vapor'z'n 14.7 psia Btu/lb	HEAT OF COMBUSTION⑦ Gross: Btu/lb	Gross: Btu/cu ft	Net: Btu/lb	Net: Btu/cu ft	Oct. No. Motor Method	
											PARAFFINS	
0.554	42.4	49.5①	-116	673	0.162	219	23,880	1,013	21,520	913	>100	1
1.049	80.3	39.3②	90	708	0.203	210	22,320	1,792	20,430	1,641	>100	2
1.562	119.6	35.4③	206	617	0.220	183	21,660	2,590	19,950	2,385	100	3
2.066	158.2	29.7②	275	529	0.221	158	21,260	3,363	19,630	3,105	99	4
2.066	158.2	30.8③	306	551	0.228	166	21,310	3,370	19,680	3,118	92	5
2.487	190.5	26.3③	321	464	0.238	136	20,970	3,993	19,400	3,693	83	6
2.487	190.5	27.4	370	483	0.234	146	21,025	4,008	19,480	3,716	89	7
2.487	190.5	27.6	386	490	0.232	154	21,090	4,016	19,520	3,722	61	8
2.973	227.4	24.0	421	451	0.240	131	20,680	4,706	—	—	96	9
2.973	227.4	24.4	441	455	0.241	136	20,630	4,700	—	—	95	10
2.973	227.4	24.1	437	440	0.235	139	20,860	4,748	—	—	73	11
2.973	227.4	24.6	448	453	0.235	140	20,750	4,722	—	—	75	12
2.973	227.4	24.4	454	440	0.234	144	20,940	4,762	19,400	4,412	25	13
3.459	264.6	21.8	497	437	0.254	124	20,620	5,455	—	—	>100	14
3.459	264.6	21.5	496	460	0.234	132	20,640	5,460	—	—	45	15
3.459	264.6	21.7	513	397	0.235	136	20,860	5,521	19,400	5,140	0	16
3.944	301.7	19.2	520	375	0.237	117	20,540	6,190	—	—	100	17
3.944	301.7	19.3	534	367	0.239	124	20,540	6,190	—	—	52	18
3.944	301.7	19.5	565	362	0.235	129	20,580	6,210	19,350	5,845	<0	19
4.428	338.7	17.8	611	331	0.236	124	20,480	6,950	19,300	6,540	<0	20
4.915	376.0	16.3	654	306	0.236	119	20,387	7,670	19,250	7,250	<0	21
											NAPHTHENES	
1.451	111.1	—	—	—	—	205	21,270	2,365	—	—	—	22
1.938	148.1	38.8②	—	—	—	—	20,390	3,020	—	—	—	23
2.422	185.2	33.8	—	—	—	167	20,130	3,730	—	—	83	24
2.905	222.3	29.4	538	594	0.270	154	20,100	4,475	—	—	77	25
											OLEFINS	
0.974	74.5	45.8①	49.8	742	0.227	208	21,645	1,614	20,295	1,513	81	26
1.451	111.0	39.2③	197	667	0.233	188	21,040	2,336	19,690	2,186	85	27
1.934	148.0	33.8②	293	580	0.234	169	20,730	3,068	19,380	2,869	87	28
1.934	148.0	33.8②	296	583	0.233	168	20,840	3,084	19,500	2,885	80	29
2.004	153.3	33.4	311	600	0.238	173	20,480	3,140	—	—	83	30
2.420	185.1	29.1	394	586	—	135⑧	20,710	3,836	19,360	3,586	91⑧	31
											DIOLEFINS	
1.869	143.0	36.6③	306	628	0.245	179	20,250	2,895	—	—	—	32
1.869	143.0	38.4③	—	—	—	—	20,310	2,900	—	—	—	33
											ACETYLENE	
0.911	69.7	—	97	905	0.231	356	21,500	1,499	20,775	1,448	80⑧	34
											AROMATICS	
2.692	206.0	35.8	553	714	0.300	169	18,210	3,751	17,480	3,601	>100	35
3.176	243.0	29.9	610	590	0.29	156	18,440	4,484	17,620	4,284	>100	36
											MISCELLANEOUS SOLVENTS	
2.002	153.2	42.6	445	690	0.268	224	13,600	2,085	—	—	—	37
2.485	190.1	35.4	—	—	—	191	14,500	2,760	—	—	—	38
1.105	84.5	78.5	464	1155	0.272	474	10,260	868	9,080	768	—	39
1.591	121.7	54.3	470	928	0.276	367	13,160	1,600	11,930	1,450	—	40
3.320	254.0	38.2	—	—	—	193	10,500	2,670	—	—	—	41
3.248	248.5	—	786	889	—	—	—	—	—	—	—	42
0.622	47.6	175.0	705	3206	0.32	970.3	—	—	—	—	—	43
											MISCELLANEOUS GASES	
1.000	76.5	—	-221	547	0.35	—	—	—	—	—	—	44
0.596	45.6	—	+270	1639	0.235	589	9,670	441	8,000	365	—	45
0.967	74.0	—	-218	514	0.311	91	4,347	322	4,347	322	—	46
1.528	116.9	-	88	1071	0.460	—	—	—	—	—	—	47
2.449	187.3	—	291	1117	0.573	124	—	—	—	—	—	48
0.0696	5.32	—	-400	188	0.031	193	61,100	325	51,620	275	—	49
1.190	91.0	—	213	1306	—	236	7,100	647	6,545	596	—	50
0.972	74.4	—	-233	492	0.311	86	—	—	—	—	—	51
1.105	84.5	—	-182	731	0.430	92	—	—	—	—	—	52
2.44	187.	—	315	1143	0.537	167	—	—	—	—	—	53

⑥ Line 17 refers to "iso-octane" used as a standard in fuel testing. Organic chemists apply the same name to 2-methylheptane.

⑦ Gas volume refers to dry basis at 60F and 30 in. Hg. For gas saturated with water at same condition deduct 1.73% from heat of combustion per cubic foot.

⑧ Average value.

⑨ At 55F.

The Squeeze Test for "Vitamin" Capsules Designed to Assure Quick Starting of Auto Engines in Cold Weather. Norman J. Boehm, pilot plant engineer, puts the squeeze on a sample selected from each batch of capsules run by this capsulating machine. This test helps him judge the strength of the capsule.

"Vitamin" Capsules Assure Cold Weather Starting For Automobile Operators

"VITAMIN" capsules, which, with the aid of a simple applicator, will enable an operator to start an engine in less than 10 seconds in a temperature as low as 25° F. below zero has been announced by C. J. Moody, vice president of The California Oil Company. The red gelatin capsules, which are $\frac{7}{8}$-inch in diameter and $1\frac{1}{4}$-inches long, are basically an ethylether fluid compound plus products of petroleum.

California Oil has been perfecting the Chevron starting fluid since 1943 when it was first used in wartime during the building of the Alcan highway. Sometime during 1950, an injecting attachment which will conform to dashboard designs and color schemes, will make the system ready for passenger cars, according to the company. It has been primarily used on trucks, tractors, busses and other commercial vehicles.

Manufactured by the Gelatin Products Division of R. P. Scherer Corporation, Detroit, the ethyl-ether compound is forced through an injection nozzle into the engine's intake manifold. Both diesel and gasoline motors are said to respond successfully.

Construction and principle of operation is basically as follows: plunger, reservoir and primer are exposed, installed in the driver's compartment. The copper wire and an injection nozzle are under the hood, near the engine, attached to the induction system of the intake manifold.

The adapter may be installed on the dashboard or the post under the steering wheel. On a wintry day, with the temperature at zero or below, the driver, unable to start his car the normal way, slips a capsule into the reservoir and presses the plunger. The instrument punctures the capsule releasing the fluid. The driver then primes the liquid, forcing it through one or more atomizing nozzles attached to the intake manifold.

Mixing with the air, the atomized fluid when subjected to the ignition spark, explodes and warms the combustion chamber, preparing it for the intake of the normal fuel. Explosion occurs because the fluid has an extremely wide explosibility range as compared with petroleum hydrocarbons. Also, it has a much lower ignition temperature. The fluid is burned up immediately and the effect is almost instantaneous.

Any service station mechanic can install the priming system, it was explained. He simply drills a hole into the induction system of the manifold to accommodate the injection nozzle, and connects the copper tubing to the drivers compartment.

Cost of adapter will be roughly $15. Each start will cost about $.09. Capsules, individually wrapped in paper, like candy will be sold in cans, which can be safely stowed away in your car or garage.

The capsule is approximately the shape and size of a robin's egg. It is roughly seven-eighths of an inch in diameter and one inch and a quarter long. It holds a quarter of an ounce, or in the neighborhood of a teaspoonful of starting fluid.

Capsules extend the life of the car's motor and battery since their action eliminates grinding and wearing, officials declared.

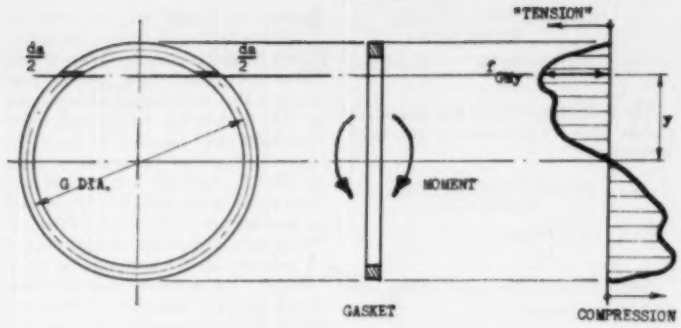

Figure 5. Gasket Under Random Stress Due to Moment.

Bending Moments and Leakage At Flanged Joints

PART II

ROBERT G. BLICK
Box 232, Sun Valley, Calif.

FIRST the basic assumption is made that the bending moment will be restrained exclusively by a redistribution of the gasket loads.

The unit[1] gasket load necessary to hold the pressure without leakage:

$$f_{oma} = +mp \qquad (1)$$

The unit gasket load not to be exceeded without danger of crushing the gasket:[2]

$$= 2y$$

However, this is the maximum value computed over the *gross* gasket area, whereas the effective operating gasket width is 2b. The apparent crushing stress allowable on the basis of a width of 2b is:

$$f_{omax} = 2y\frac{n}{2b} = \frac{yn}{b} \qquad (2)$$

The unit gasket load due to the bolting:

$$f_{oB} = +\frac{\text{Bolt Load}}{\text{Effective operating gasket area}}$$

$$= +\frac{A_B S_{op}}{2b\pi G}$$

The unit gasket load due to hydraulic end load:

$$f_{op} = -\frac{\text{Hydraulic End Load}}{\text{Effective operating gasket area}}$$

$$= -\frac{\pi/4\, G^2 p}{2b\pi G} = -\frac{Gp}{8b}$$

The "extreme fiber" unit gasket load due to a bending moment:

$$= (\pm) f_{oM} \qquad (3)$$

Total unit gasket load =

$$f_o = f_{oB} + f_{op} + f_{oM}$$

$$= \frac{A_B S_{op}}{2b\pi G} - \frac{Gp}{8b} \pm f_{oM}$$

From formula (1):

$$f_o \geq f_{oma}$$

$$\therefore\ f_{oB} + f_{op} - f_{oM} \geq f_{oma}$$

$$-f_{oM} \geq f_{oma} - f_{oB} - f_{op}$$

$$f_{oM} \leq f_{oB} + f_{op} - f_{oma}$$

[Criterion for sufficient gasket pressure] (4)

IN PART I several ideas of a qualitative nature were discussed, toward the development of a simple method to define the moment capacity of flanged joints. Part II presents a mathematical approach deriving some of those relationships necessary to more accurately define this capacity. Introduced is a "leakage envelope," a graph on which the operating moment-pressure conditions may be plotted, compared with the capabilities of the joint, and the margin against leakage readily determined.

From formula (2):

$$f_o \leq f_{omax}$$

$$f_{oB} + f_{op} + f_{oM} \leq f_{omax}$$

$$f_{oM} \leq f_{omax} - f_{oB} - f_{op}$$

[Criterion for excessive gasket pressure] (5)

It is now necessary to determine f_{oM}. This may be done with the following assumptions:

(a) That each circle defined by the gasket surfaces remains plane at the flange faces.

(b) That the unit load distribution on the gasket due to bending moment has the customary "triangular" pattern, increasing uniformly from the centroidal axis, or:

(b)′ That the unit gasket load distribution due to bending moment has some other pattern.

Assuming (a) and (b),

$$f_{oM} = \frac{M}{\text{Section modulus of gasket}}$$

$$= \frac{M}{\pi/4\, G^2 2b}$$

Then formula (4) becomes:

$$\frac{M}{\pi/4\, G^2 2b} \leq \frac{A_B S_{op}}{2b\pi G} - \frac{Gp}{8b} - mp$$

$$M \leq \frac{G A_B S_{op}}{4} - p\frac{\pi G^2}{2}\left(\frac{G}{8} + bm\right) \qquad (6)$$

And formula (5) becomes:

$$\frac{M}{\pi/4\, G^2 2b} \leq \frac{yn}{b} - \frac{A_B S_{op}}{2b\pi G} + \frac{Gp}{8b}$$

$$M \leq p\frac{\pi G^3}{16} + \frac{\pi G^2 yn}{2} - \frac{G A_B S_{op}}{4} \qquad (7)$$

On the other hand, assuming (a) and (b)′, one may refer to figure 5, which shows the gasket under some symmetrical (but random) stress pattern due to bending moment. Working with this figure, equilibrium requires that:

$$M \approx 2\int_0^{G/2} f_{oMy}\, y\, da$$

Let f_m = some mean value of f_{oMy}, such that

$$M = 2f_m\int_0^{G/2} y\, da$$

but $\int_0^{G/2} y\, da \approx Q =$ Statical moment of gasket

$$\therefore\ M = 2f_m Q = 2f_m bG^2$$

$$f_m = \frac{M}{2b\,G^2}$$

Let the maximum permissible value for f_m be

$$f_m = f_{oM}$$

$$f_{oM} = \frac{M}{2b\,G^2}$$

Then formula (4) becomes:

$$\frac{M}{2b\,G^2} \leq \frac{A_B\,S_{op}}{2b\,\pi\,G} - \frac{Gp}{8b} - mp$$

$$M \leq \frac{G\,A_B\,S_{op}}{\pi} - p\left(\frac{G^2}{4} + 2b\,G^2\,m\right) \quad (8)$$

And formula (5) becomes:

$$\frac{M}{2b\,G^2} \leq \frac{yn}{b} - \frac{A_B\,S_{op}}{2b\,\pi\,G} + \frac{Gp}{8b}$$

$$M \leq p\,\frac{G^2}{4} + 2\,G^2\,yn - \frac{G\,A_B\,S_{op}}{\pi} \quad (9)$$

Relationships (8) and (9) express the *maximum* possible moments conceivable[3] (under the basic assumption) without leakage. They correspond to the "maximum possibility" case of Figure 4.

Again using the example in "Modern Flange Design," the "leakage envelopes[4] of Figure 6 have been drawn, showing maximum bending moment versus pressure. The ordinates for the "rectangular" distribution are $4/\pi$ times the ordinates for triangular distribution.

It is of interest, at this point, to compare another assumption, other than that the moment is resisted exclusively by a redistribution of gasket pressures. Assuming that the unit gasket load does not change with application of bending moment, the bolts must resist the moment. This is the (improbable) "Behavior No. 2" mentioned earlier.

Another "leakage envelope" may be constructed on this basis.

The bolt stress due to hydraulic end load:

$$f_{bp} = \frac{\text{Hydraulic end load}}{\text{Bolting Area}}$$

$$= \frac{\pi/4\,G^2\,p}{A_B}$$

The bolt stress due to the minimum gasket load requirement (to hold pressure):

$$f_{bg} = \frac{\text{Area of gasket times (m p)}}{\text{Bolting Area}}$$

$$= \frac{\pi\,G\,2b\,mp}{A_B}$$

The "extreme fiber" bolt stress due to bending moment:

$$= f_{bM}$$

Assuming that the bolt stress due to moment is "triangularly" distributed:

$$f_{bM} = \frac{\text{Moment}}{\text{Section modulus of bolting area}}$$

$$= \frac{M}{CA_B/4} \text{ (C = diameter of bolt circle)}$$

The total bolt stress must not exceed S_{op}, the allowable bolt stress.

$$S_{op} \geq f_{bp} + f_{bg} + f_{bM}$$

$$S_{op} \geq \frac{\pi\,G^2\,p}{4\,A_B} + \frac{2\pi\,G\,b\,mp}{A_B} + \frac{4M}{C\,A_B}$$

$$M \leq \frac{C\,A_B\,S_{op}}{4} - p\,\frac{\pi\,G\,C}{2}\left(\frac{G}{8} + bm\right)$$

Figure 7 defines the "leakage envelope" under this assumption. It would be more correct to call this envelope an "allowable bolt stress envelope," since, with this type of behavior, the flange would not leak until the bolts failed. The writer would speculate that, if joints leaked only when bolts failed, there should indeed be very few cases of joint leakage.

As an example of how these "leakage envelopes" may be drawn for any flange, bolt, and gasket combination, Figure 8 has been made for an 8-inch-150-pound raised face carbon steel flange with a compressed asbestos gasket 8½ inches i.d. by ½ inch wide. The bolts are assumed to be A-96, Grade A. The flow temperature is taken as 500° F., and the bolt temperature is assumed to be 450° F. (90 per cent of flow temperature). Under these circumstances, the flange is operating at its primary service pressure rating of 150 psi. Now, *assuming that the flange would not fail*, inasmuch as the specified bolts have an allowable stress of 16,250 psi., at a "factor of safety" of 4, the following data can be set up:

Bolts	Gasket
8 at ¾" dia.	G = 9"
S_{op} = 16,250 psi.	b = ¼"
	m = 2.5
A_B = 2.42 sq. in.	y = 4500
	n = ½"

Referring to formula (6):

$$M \leq \frac{G\,A_B\,S_{op}}{4} - p\,\frac{\pi\,G^2}{2}\left(\frac{G}{8} + bm\right)$$

$$M \leq \frac{9 \times 2.42 \times 16{,}250}{4}$$

$$- p\,\frac{3.1416 \times 9^2}{2}\left(\frac{9}{8} + \frac{1}{4} \times 2.5\right)$$

$$M \leq 88{,}300 - 222p$$

When p = O, M ≤ 88,300 inch pounds

When M = O, $p = \frac{88{,}300}{222} = 398$ psi.

A straight line is drawn intersecting these points, forming part of the leakage envelope.

Referring to formula (7):

$$M \leq p\,\frac{3.1416 \times 9^2}{16} + \frac{3.1416 \times 9^2 \times 4500 \times \frac{1}{2}}{2} - \frac{9 \times 2.42 \times 16{,}250}{4}$$

$$M \leq 143\,p + 287{,}000 - 88{,}300$$

$$M \leq 143\,p + 198{,}700$$

at p = O, M = 198,700 inch pounds

at p = 100, M = 213,000 inch pounds

A straight line is drawn intersecting these points. Since it does not intersect the first line, it is evident that "crushing" the gasket is not a factor in this case. This would show that a better

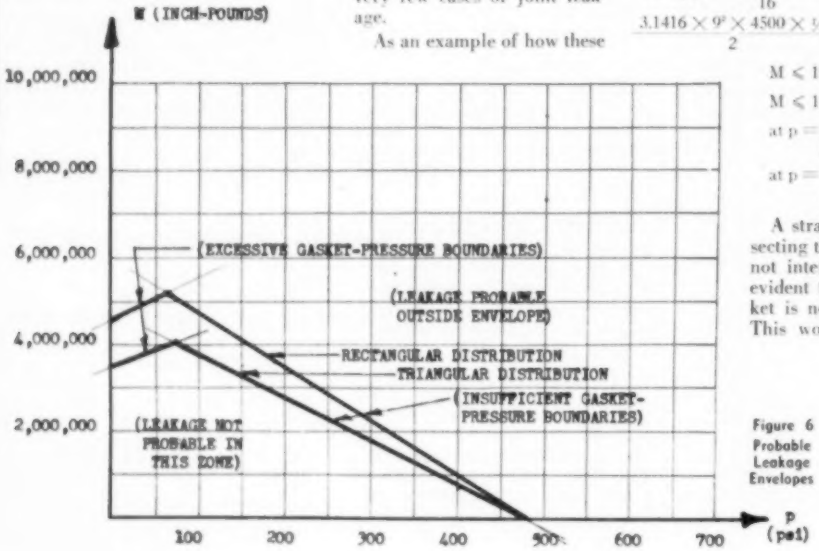

Figure 6
Probable Leakage Envelopes

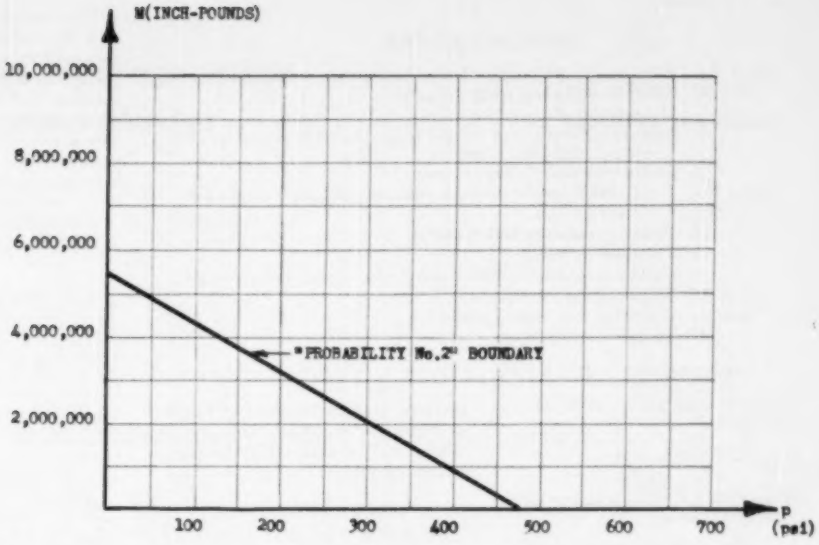

Figure 7
Improbable "Leakage" Envelope

choice of gasket material[5] could have been made. A gasket with a lower y generally has a lower *m*, and consequently would be more efficient. It would raise the right-hand end of the first line [from formula (6)], allowing greater moments at higher pressures.

Getting back to the primary pressure rating of the flange, a heavy line has been drawn vertically from 150 pounds on Figure 8. Study of the moment defined by its intersection with the leakage envelope leads to the following conclusion:

That if the flange will not be overstressed with A-96, Grade A bolts, then it will probably not be overstressed at 150 psi. *with a bending moment of 55,000 inch pounds simultaneously applied.*[6] Some readers may care to run a check on this flange for these operating conditions, with the specified bolting. It should be noted that some of the B 16E flanges do not hold up under a standard pressure analysis[7]—but work satisfactorily despite this mathematical obstacle.

Figure 9 has been constructed for this same example on a quite different, conservative, basis. Starting with the conservative assumption that the flange-gasket-bolt combination can (at 150 psi.) carry *no* bending moment without danger of leakage or danger of flange failure, the following can be deduced:

Referring to formula (6):

$$M \leq \frac{G\,A_B\,S_{op}}{4} - p\,\frac{\pi\,G^2}{2}\left(\frac{G}{8} + bm\right)$$

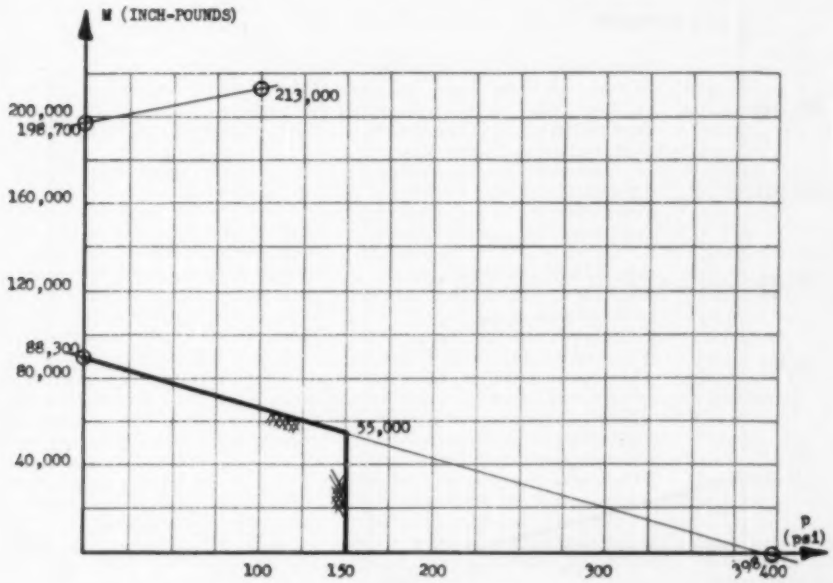

Figure 8
Leakage Envelope for 8-Inch, 150-Pound Flange

NOMENCLATURE

H_p or H_{op}	Total gasket load required to hold pressure without leagage
2b	Effective operating width of gasket
G	Mean gasket diameter
m	Gasket coefficient—ratio of the required gasket pressure to the internal hydraulic pressure
p	internal hydraulic pressure (psi.)
H_y or H_{oy}	Total gasket load required to initially yield (set) the gasket
H_o	Total gasket load
M	Bending moment (inch pounds)
n	Total gasket width
y	Gasket constant—"yield" stress (psi.) of the gasket material
A_b or A_B	Total bolting area (sq. in.)
S_b or S_{op}	Operating bolt stress (psi)
C	Diameter of bolt circle

Using the same gasket as in the preceding example,

$$M \leq \frac{9\,(A_B\,S_{op})}{4} - 222\,p$$

at p = 150 psi (the primary service pressure rating)

$$O \leq \frac{9}{4}\,(A_B\,S_{op}) - 222 \times 150$$

$$^{8}(A_B\,S_{op}) = \frac{222 \times 150}{2.25} = 14{,}800$$

Using this value of $(A_B\,S_{op})$ to obtain a maximum permissible moment at p = O,

$$M \leq \frac{9}{4}\,(14{,}800) - 222 \times 0$$

M = 33,200 inch pounds

By drawing a line intersecting this point and M = O at 150 psi., the conservative leakage envelope of Figure 9 is drawn for this joint. That this *is* a conservative envelope may be demonstrated as follows:

$$A_B\,S_{op} = 14{,}800$$

But $A_B = 2.42$ sq. in.

$$S_{op} = \frac{14{,}800}{2.42} = 6100 \text{ psi.}$$

In other words, on this basis even the use of Grade A-107 carbon steel bolts, with an S_{op} allowable of 6875 psi. would be excessive for these flanges. In fact, these bolts would not even develop the load necessary to initially yield the gasket for proper setting. Figure 8 is probably the more correct envelope for this joint (provided A-96-A bolts are used).

There are several factors that influence the leakage envelopes of flanged joints. Chief among these is the change in bolt-load that occurs when internal pressure and bending moment are applied. In Part III some of these factors are evaluated, and an analytical method is developed to draw envelopes that include the effect of the dynamically changing bolt-load.

End of Part II. Part III will appear in an early issue.

NOTES

[1] It is worthy of note that British investigations tend to indicate that the ratio of the (total) hydraulic load to the net (total) gasket load is determinate, rather than the ratio of the hydraulic pressure to a unit gasket load. This would tend to require a gasket load **per inch of circumference** (not related to gasket width) dependent on diameter, pressure and a gasket constant.

[2] The unit gasket load not to be exceeded without damaging the flange contact faces is not considered here.

[3] Careful retightening of the bolts after application of pressure might in effect produce this distribution pattern, if it would not occur normally.

[4] These might more correctly be called "leakage envelopes with fixed bolt load," since the installed bolt load will determine the gasket load. As an example of what this means, the bolt load has been taken as A_{Bact} (41.6 sq. in.) times the **allowable** operating bolt stress of 13,400 psi. If the bolt load had been taken as $(A_{Bact} + A_{Bmin})/2$, a smaller value, the envelopes would be smaller. The "crushing" part of the envelope would move up, but the "insufficient gasket pressure" part would move to the left. If the bolt area and/or bolt stress were increased, the "crushing" part of the envelope would move down, but the "insufficient gasket pressure" part would move to the right.

[5] Or perhaps a smaller width.

[6] Due to the relatively small effect on the flange-moments of shifting part of the H_G load to H_D, and vice versa. This will introduce an effective "torsion" on the cross-section of the flange, which can probably be ignored.

[7] Due to having been in common use before the development of the present method of flange stress analysis. This particular case should prove satisfactory.

[8] An "effective bolting," so to speak.

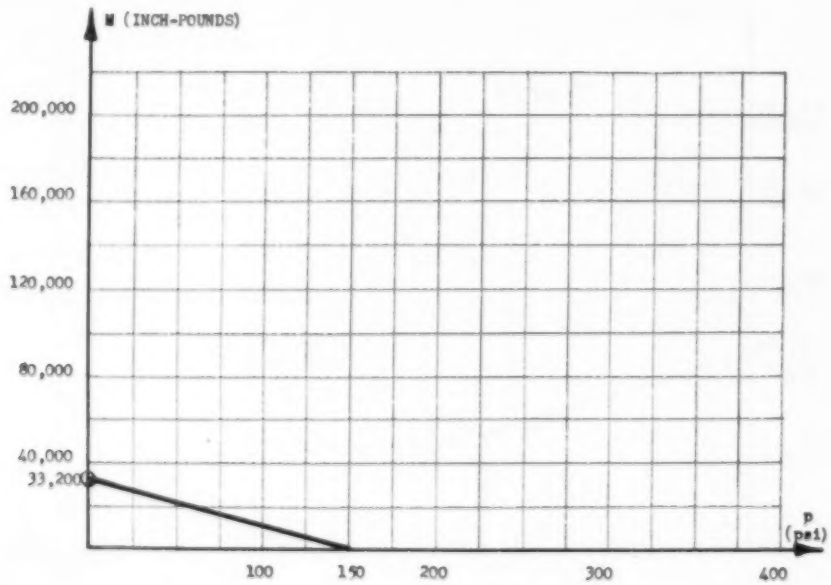

Figure 9
Conservative
Leakage
Envelope

High-Pressure Hydrogenation Of Carbonaceous Matter

PART V

THE LIQUID PHASE IN INDUSTRY (Continued)

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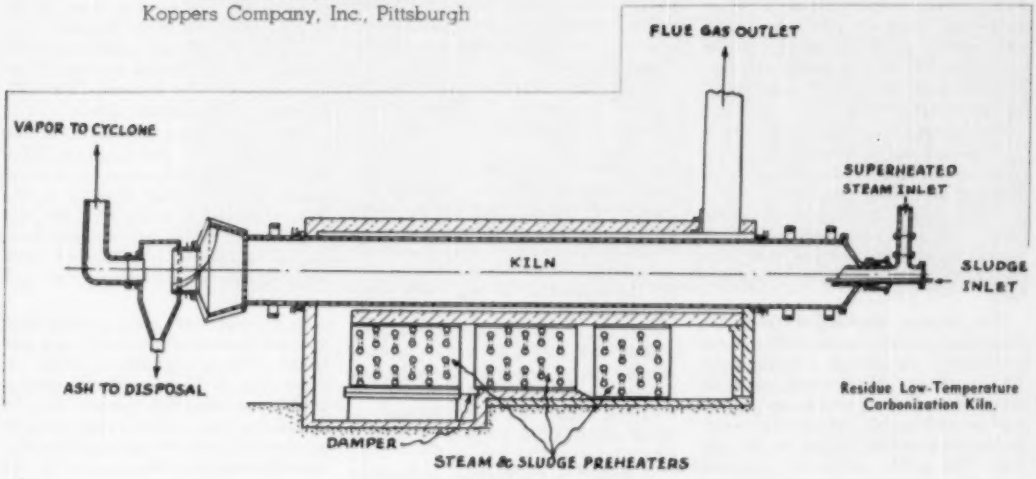


Residue Low-Temperature Carbonization Kiln.

AT THE present stage of development, residue processing is probably the crux of the entire hydrogenation process. It defeated the early work with lignite carried out at Leuna, and difficulties encountered in this step of the process were one of the main reasons why it was decided to switch hydrogenation operations at Billingham from coal to creosote oil feedstock. Nevertheless, the problem has found moderately satisfying industrial solution and a more recent development, being studied on a pilot-plant scale, promises to furnish an improved technique.

Residue processing, of course, refers to the removal of inorganic and unconverted organic solids, along with a portion of the total residual asphalts (i.e. compounds which are soluble in benzene but insoluble in petroleum ether) from the h.o.l.d. (heavy-oil let-down), the least volatile portion of the liquid-phase products.

Potential processes for separating solid wastes from the useful heavy oils of the h.o.l.d. include extraction, filtration, distillation, and low-temperature carbonization. Low-temperature carbonization is probably the simplest possible process but, used by itself, it results in prohibitive oil losses. Filtration is an attractive way to process residue. It removes all solid matter with high efficiency and is actually being used for the production of specialty products which will be discussed later in this article. For normal hydrogenation processes, filtration is not however, satisfactory because of inadequate filtration rates.

Industrial methods practiced in all present-day coal hydrogenation works involve a combination of centrifuging and low-temperature carbonization of the centrifuge residue. A promising new approach, which has not yet been tested industrially, however, involves the steam flashing of the h.o.l.d.

***HIGH-PRESSURE** hydrogenation shows certain advantages for the manufacture of liquid fuels and may eventually find extensive application in this country as crude oil supplies become inadequate.*

In this fifth section of an eight-part series the author reviews problems encountered in the processing of residues.

Residue processing is at the present time still the crux of the hydrogenation process. In standard plants it is carried out by centrifugation followed by low-temperature carbonization. In the most recent hydrogenation plant a steam-flashing scheme is being employed. Specialty products can be produced by filtering the products of the liquid phase. Some recent processes involving the hydrogenation of carbonaceous matter at moderate pressures and high temperatures are arousing interest in the United States and England.

1) Centrifugation

A typical heavy-oil let-down product (from bituminous coal liquefaction) contains 20-27 percent benzene-insoluble matter and 18 percent asphalt. The mean particle size of the solids is about 1.5 micron.

As received, it is very difficult to subject the h.o.l.d. to adequate centrifuge separation. This is largely due to the fact that the let-down solids are held in a colloidal structure which must be broken by some means before centrifuging can have any effective meaning.

The colloidal system can be broken up by the addition of electrolytes, an approach which has the disadvantage, however, of introducing a corrosion problem or of raising the solids content of the centrifuge feed. The preferred method which is generally employed to prepare the let-down for the centrifuging operation is, therefore, the addition of a suitable diluent oil.

It has been shown[1] that paraffinic oils are most highly suited as diluent in this operation. Particularly good results have been obtained with heptane.

Actually, this consideration is somewhat academic because, in industrial operation, it is necessary to draw the centrifuge diluent oil from other stages

in the process. The common source of this material are the heavy bottoms of the primary (A-) distillation of the liquid phase cold catchpot product, and the overhead oils obtained in the course of the low-temperature carbonization. Since these oils must be returned to the liquid phase stalls anyway, it is good technique to employ them for this useful diluent function on the way. They are, of course, recovered, partly as direct recycle of the centrifuge filtrate and partly as overhead obtained in the carbonization of the centrifuge residue.

The centrifuging process is generally carried out in continuous Laval plate centrifuges of 24 inches drum diameter and 3200- rpm. rotary velocity. The diluted centrifuge feed contains about 16.5 percent solids. A typical throughput rate per centrifuge is 3.5 to 4-tons-per-hour centrifuge feed.

The residue discharged from the centrifuge contains some 33-40 percent solids while the filtrate contains some 10-12 percent solids which must be returned to the converters and represent an undesirable but as yet economically unavoidable ballast in the system. The solids which are recycled with the centrifuge filtrate represent about 50 percent of the total solids in the h.o.l.d.

Good centrifuging efficiency can be obtained by operating at temperatures above 250° F. Normal industrial operating temperature is 320° to 390° F.

Urban[2] has reported attempts to subject the Laval residue to a second separation in a continuous solid-bowl centrifuge. By this means it was possible to obtain a residue of 60 percent solids content. Some 67 percent of the total solids must, however, be returned to the liquefaction stalls in the combined filtrate oils. The residue of the second centrifuge is difficult to handle because of its high solids content. Since this stream contains only about 10 percent of the original let-down oil, however, it has been suggested to dispense with the low temperature carbonization of this material altogether. The disadvantages of this two-stage centrifugation method seem to exceed any benefits which might be derived from it.

2) Low-Temperature Carbonization

The residue from the centrifugals still contains appreciable quantities of useful oil which must be recovered and recycled to the liquid phase stall. Industrially, this separation is carried out by subjecting the material to a low-temperature carbonization process. The useful oils are recovered overhead, essentially free of solids and asphaltous matter. The residue of this operation contains some 65 percent ash and 35 percent coke derived from the organic solids and the decomposed asphalts which are thus purged from the system. The heating value of the high-ash residue is about 6000 Btu. per pound. If desired it may be burned, but its objectionable high-ash characteristics make it a most unsuitable fuel and it is often considered expendable waste.

Two types of furnace have been developed to handle the fluid masses which must be turned into solid residue in the course of carbonization. The worm type furnace is more commonly employed for processing the residue of lignite liquefaction, while the ball furnace is more common in plants hydrogenating bituminous coal. Both types can be employed usefully for the separation of heavy oils from the catalyst and asphaltous residue in the h.o.l.d. of oil hydrogenation plants.

Both the ball and worm furnace employ the principle of carbonization in thin layers which yields highest oil recovery. The ball type furnace is more universal in its field of usefulness.

A typical worm furnace consists of two horizontal steel tubes, 3 feet diameter and 48 feet long, arranged above each other inside a brickwork gas-fired furnace. Each tube is fitted with blades fixed with a slight pitch on to a central rotating shaft, which scrape the inner walls of the tube free from adhering coke. The central shaft rotates at about 1 rpm. Loose iron bars are attached to the blades so that, as the unit rotates, the bars are lifted to fall later with sufficient force to dislodge coke deposited on the blade.

The ball furnace consists of a slightly inclined 6.5 feet diameter by 33 feet long tube which rotates at about 9 rpm. inside a gas heated brickwork chamber. The feed is preheated and injected into the furnace together with superheated steam. On its passage through the rotating chamber the coke is crushed by specially shaped tumbling milling elements which are designed to present a maximum surface. The coke is discharged at one end of the rotating tube and is immediately water-quenched for subsequent disposal.

The overhead vapors from the carbonization operation are condensed and returned to the process.

The drums are constructed of forged, or preferably of cast steel. The ball furnaces are, moreover, provided with an internal liner of 25 percent Cr steel. In order to minimize the wear on the drum, it is desirable to employ the lowest feasible operating temperature, generally between 1020° and 1100° F. (measured at the inside wall of the drum).

A typical worm furnace as described above can handle an hourly feed throughput of 2.5 tons or about 35 percent less than a ball furnace of the dimensions outlined in this chapter. Some 1.25 million Btu. must be supplied by the fuel gas for every ton of residue processed in the furnace.

The recovered oil yield depends largely on the asphalt content of the feed oil and varies between 70 and 85 percent of the solid-free feed.

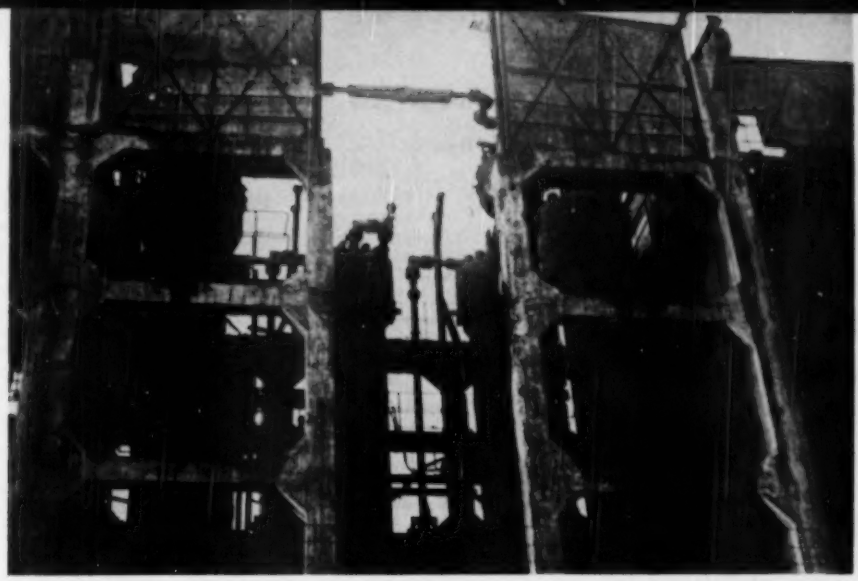
One of the main drawbacks of the low-temperature carbonization kilns are their high maintenance requirements. The limiting element is the drum liner which wears out at the rate of about 0.3 inches per hundred days. Actual operating time between liner replacements varies between one and four months.

Low-temperature carbonization kilns will not operate satisfactorily as a rule if the ratio of asphalts to solids exceeds 1:3. A higher asphalt content tends to choke the furnaces by the formation of a plastic intermediate product of carbonization. From this consideration one may appreciate the close interdependence of the various steps in the hydrogenation process, since the operation in the liquid phase must be carried out with a view to maintaining the asphalt content at a level low enough to permit satisfactory operation of the low-temperature carbonization furnaces.

3) Miscellaneous Methods of Residue Processing

The U. S. Bureau of Mines plant at Louisiana, Mo., will try to sidestep the difficult and unsatisfactory residue processing combination of centrifuging plus low-temperature carbonization by employing a steam flashing method. Originally described by Hupfer,[3] this method of residue processing has been reported in some detail by Savich and co-workers,[4] who were able to flash as much as 67 percent of the h.o.l.d. by the addition of 500 percent superheated steam, with an operating temperature of 750° F. The overhead product was reported to contain practically all of the original oil plus 44 percent of the asphalts found in the h.o.l.d. Separation from solids was practically quantitative. The conditions to be employed industrially will presumably be an economic compromise. Savich's data indicate that this method of processing the residue of the liquid phase holds much promise.

After early disappointing experience with the classical two-step processing procedure described above, the Eng-



High-Pressure Coal Stall

lish hydrogenation plant at Billingham changed to a system of direct flashing of the h.o.l.d.[5] The sludge is simply heated while still under pressure and then released to atmospheric pressure. The vaporized oil is condensed and recovered overhead, the solids and most of the asphalts are withdrawn for disposal. Oil recovery by this process is not equal to that obtained by the more difficult two-step process. Nevertheless, the flashing procedure was felt to be more economical.

The only method by which the solids can be isolated from both heavy oil and asphalts is filtration. This type of separation becomes especially significant when the desired product is primary bitumen or very heavy oil, devoid of ash, which can be converted to a low-ash (electrode-grade) coke by destructive distillation. Pfirrmann[6] has investigated the requirements for proper filtration performance and finds that it is greatly influenced by the manner in which the liquid phase hydrogenation has been carried out. In order to obtain a properly filterable product, it is necessary to operate with a pasting oil rich in aromatics and to limit the hydrogen consumption and consequently the degree of hydrogenation. At 4400 psi., a low throughput and temperature in the liquid phase are desirable. At 10,300 psi., these restrictions are less severe. A study of various filter types led Pfirrmann to the conclusion that a Dorr continuous filter, used with a filter-aid precoat gives the most satisfactory performance. The use of ceramic pressure filters is not so highly recommended (although they have been employed industrially, e.g. in the Pott-Broche process). The drawback of this type of filter is a rapid fouling rate and difficulties encountered in the regeneration. Maximum filter rates obtained with a Dorr filter are 65 pounds per square foot per hour.

Attempts have been made[2] to apply filtration to the concentration of the residue from the centrifuging operation of normal h.o.l.d. The objective of these investigations was to obtain a filter cake with a 60 percent solids content which would obviate the need for low-temperature carbonization. The operation was carried out with the addition of a diluent oil (a middle oil high in aromatics). Because of the appreciable vapor pressure of the diluent oil at the proposed operating temperature (400-575° F.), the use of a vacuum filter was excluded and a continuous pressure filter was employed. Filtration rates of about 70 pounds per square foot per hour were obtained, about one-half of what the experimenters considered to be industrially feasible.

A type of steam distillation, employing only 200 pounds steam per ton charge has been considered for the treatment of the centrifuge residue[2] prior to its subjection to low-temperature carbonization. It was possible to raise the solids content from 35 to 41 percent. Experimental results were, however, not very encouraging, largely because the total asphalt quantity was increased in the course of this operation, presumably due to the action of the free oxygen contained in the steam.

Scrubbing of the Recirculation Gases of the Liquid Phase

In the course of the hydrogenation process, appreciable quantities of gaseous hydrocarbons are formed. To a large extent, these are retained by the oil products of the operation—the h.o.l.d. and the cold catchpot. However, considerable quantities of these products are not thus removed and tend to accumulate in the recycle hydrogen stream, together with carbon monoxide and nitrogen which are brought in as impurities of the make-up hydrogen.

Several methods are available to reduce this build-up of contaminants in the circulating hydrogen stream: 1) The hydrogen stream may be scrubbed by means of oil; 2) A portion of the hydrogen effluent from the converters may be continuously bled from the system and purified by low-temperature fractionation, if so desired; 3) The entire circulating hydrogen stream—or a portion thereof—may be subjected to low-temperature cooling for the removal of hydrocarbons by condensation.

Oil washing is the method of purification which has generally been selected for liquid phase hydrogenation units operating at 4400 psi. A middle oil obtained as an intermediate product of the vapor phase is generally employed as solvent in this operation. The scrubbing operation is carried out at full stall pressure. Stripping is carried out by releasing the pressure in two stages, whereby the first stage (to 750 psi.) evolves a "lean" gas containing much hydrogen and the second stage yields a gas rich in light hydrocarbons.

Frese[14] has shown that hydrogen losses occurring in the course of oil scrubbing at 10,300 psi. are high but that, in spite of this, it is a more economical operation than gas purge unless the purged hydrogen is purified in a low-temperature plant and recycled to the liquefaction process.

One definite advantage of purge op-

eration is the continuous removal of carbon monoxide and nitrogen from the system. It is therefore possible to employ a less pure feed gas to the liquid phase. In actual practice, these advantages must be looked upon as problematical, however, because make-up hydrogen for both liquid and vapor phase is generally taken from the same source and the permissible CO-content of hydrogen reaching the vapor phase is severely limited by the dangers and drawbacks of the methanization reaction.

Distillation of the Cold Catchpot Product (A-Distillation)

The middle oil and gasoline fractions are separated from the heavy oil (above 620° - 660° F.) with which they are associated in the cold catchpot by distillation after decantation of the water layer. The operation is carried out in conventional tray or Raschig-ring packed columns using fuel gas as the primary heat source. The packed construction is generally preferred because there is less disturbance due to coking in the column. The towers are operated at atmospheric pressure with a reflux ratio of 2:1. Some plants choose to preheat the feed to the column under 750-psi. pressure in order to prevent erosion and coking difficulties in the preheater furnace. The tower is thus operated primarily as a rectification unit, with little attention being paid to the stripping efficiency.

In German plants, the entire overhead of the A-distillation is submitted to the vapor phase (whereby care must be taken that any fraction boiling above 660° F. is excluded because it endangers the catalyst). In the English plant at Billingham, further separation is performed on this fraction. The liquid-phase gasoline is acid-treated and sold as such, in spite of its low octane number. The middle oil alone is hydrogenated further in the vapor phase.

The separation of liquid-phase gasoline from middle oil is strongly championed by Gunther[15] who points out that these two fractions will yield a higher-grade gasoline if treated individually in the vapor phase.

Skinner and co-workers[16] recommend the complete elimination of the let-down and distillation between the liquid- and vapor-phase stalls. A crude cut is to be made by refluxing the hot catchpot product under hydrogenation pressure. These authors feel that the Ruhrol single-stage catalyst (to be described later) is sufficiently sturdy to stand up under the impact of moisture, sulfur, ammonia, tar acids, entrained heavy oil, etc., which will reach the vapor phase under such circumstances.

Miscellaneous Products of the Liquid Phase

In the past, high-pressure hydrogenation has been employed primarily for the production of gasoline from carbonaceous materials. There has been speculation, however, that the future of the process in the United States rests primarily in the production of heavy fuel oils which can be manufactured in a single phase and with comparatively little hydrogen consumption.

One German plant (Blechhammer) has been operated with a view to the simultaneous production of heavy fuel oil and gasoline. The operation was carried out at 10,300 psi. The pasting oil employed was a recycle middle oil, i.e. the heavy oil and the gasoline fractions were removed from the system for final processing to product specifications. Throughput rates as high as .065 tons amf. coal per cubic foot reactor space per hour were employed. The catalyst was the normal iron sulfate-sodium sulfide combination. The following yields were achieved in the liquid phase:

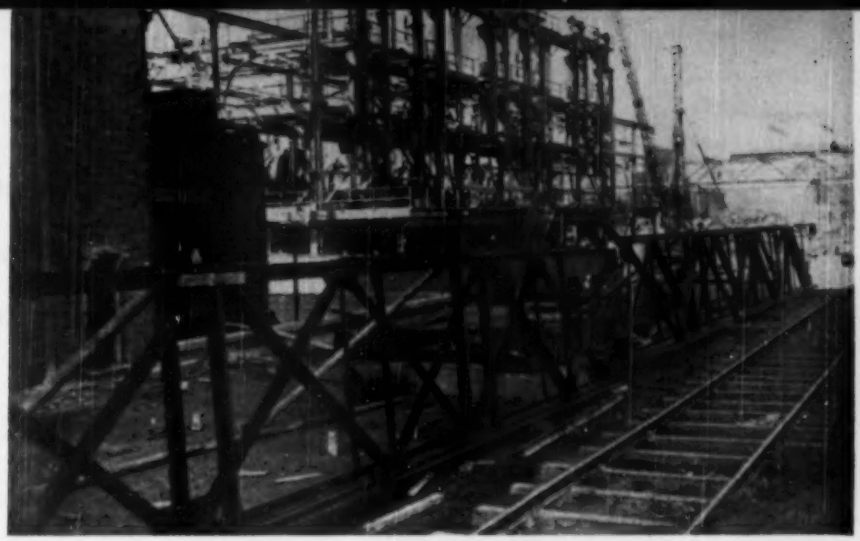
Gasoline plus middle oil	46.7%	(on amf. coal)
Heavy oil boiling above 620° F.	21.5%	(on amf. coal)
Hydrocarbon gas	19-20%	(on amf. coal)
Conversion	96%	
Hydrogen consumption	app. 3.5%	(on amf. coal)

The U. S. Bureau of Mines[7] has proposed two processes for the manufacture of fuel oil from coal. In one of these, hydrogenation is carried out at 10,300 psi. with high throughput rates. The oils which are volatile under the conditions prevailing in the hot catchpot are distilled and the lightest fractions and the fuel oil are recovered for final processing. The middle oil is recycled to the pasting stage. Part of the h.o.l.d. makes up a portion of the pasting oil, but the main body of this fraction is filtered and the filtrate sent to distillation. Oil adhering to the filter cake is steam stripped. The alternate process employs heavy oil as pasting oil for the hydrogenation stage, but operates a coal extraction process simultaneously, in which the middle oil produced during the hydrogenation serves as solvent. The main product of the extraction (carried out at 2200 psi.) is heavy fuel oil.

One important potentiality of the mild operating conditions employed during processes aimed at the production of heavy fuel oils is the production of gasoline from coal in higher yields than can be obtained by the processes now being practiced. It has already been pointed out that one of the principal drawbacks of liquid phase operation is the difficulty of exerting accurate process control because of the high degree of catalyst dilution. As a result, operation of the liquid phase for the predominant formation of light oils of the middle oil and gasoline range, results in unduly high yield losses to hydrocarbon gases. Gas formation under the mild hydrogenation conditions leading to predominant fuel oil production is much lower. It has been found that the fuel oil formed at 10,300 psi. is quite low in asphalt content. The treatment of the heavy fuel oil produced in the liquid phase over a fixed catalyst is therefore probably feasible. The results obtained in the liquid phase operation at Blechhammer lead to the justified hope that a two-stage liquid-phase process (primary liquefaction to heavy fuel oil followed by secondary splitting over a fixed-bed catalyst) will render gasoline plus middle oil in yields of about 65 percent, 7-8 percent higher than can be obtained from a normal one-step liquid phase operation.

As the throughput rates in the liquid phase are further increased, the degree of breakdown of the primary liquefaction products is progressively reduced. Operating at .085 tons amf. coal per cubic foot reactor space per hour, it becomes possible to produce a liquid product of high molecular weight with a hydrogen consumption of only about 1 percent. The nature of the product obtained by this mode of operation is not unlike the product of Pott-Broche extraction (see Part II, January, 1950, *PR*), and the process is referred to as extractive hydrogenation. The products can be diluted with light oils and filtered. After topping the filtrate, a residue of insignificant ash content is obtained which is an ideal raw material for electrode coke production and which has been experimentally employed as fuel in powdered coal engines. For this latter purpose, the product of extractive hydrogenation has the disadvantage of exhibiting a high ignition point (750° F.) which must be lowered by the addition of promoters.

Filtration rates are of foremost importance for a satisfactory operation of extractive hydrogenation. It is found that any change of operating conditions favoring hydrogenation results in lower filtration rates. Thus, operation with a catalyst, at high hydrogen pressures, or at low temperatures tends to lower the filtration rates.[8] High pressures are nevertheless considered industrially preferable because of



Low-Temperature Carbonization Furnaces

higher throughput rates and better coal conversion.

Operation of extractive hydrogenation has been repeatedly suggested at sites where coke-oven gas is freely available. Because of the low hydrogen consumption in high-pressure plants of this type, the available gas from even a medium-size coke-oven plant would go a long way toward satisfying the unit's entire hydrogen requirements. Weller and co-workers[9] have studied the applicability of unreformed, unconverted coke-oven gas to liquid phase hydrogenation of coal and found that liquefaction proceeds satisfactorily although the results were not quite as good as those with pure (i.e. 96 percent) hydrogen at the same partial hydrogen pressure. For satisfactory conversion yields, the partial pressure of hydrogen had to be at least 1000 psi.

A combined coal hydrogenation and distillation process operating in countercurrent fashion has recently been taken into pilot plant operation by the French firm Cie. Francaise des Essences Synthetiques.[10] The process attempts to minimize secondary breakdown of desirable oil fractions by removing them from the high-temperature zones almost as soon as they are formed. Coal paste is introduced at the top of an autoclave divided into several compartments (trays) which provide for proper liquid and gas contact. At the same time hydrogen is introduced at the bottom of the unit. Total pressure is between 3750 and 7500 psi. The temperature relation is adjusted to range from 930° F. at the bottom of the column to 750° F. at the top. An iron sulfide base catalyst is employed. The underlying idea of this mode of operation is that distillable oils are removed from the reaction zones toward cooler regions almost instantly after formation. The heavy and unconverted materials travel toward zones in which the temperature conditions are more drastic. Up to 90 percent of the raw material is said to be converted to useful oils. Hydrogen consumption is about 10 percent.

Primary Hydrogenation at Moderate Pressures

Before leaving the subject of primary high-pressure hydrogenation, a derivative gasification process should be mentioned which is currently being studied in the United States and in England.

The prime objective of the English studies is to convert coal to methane by direct hydrogenation. The process is carried out in a hydrogen atmosphere at 750 psi. and at 1470°-1650° F.[11] The process is thermally self-sufficient, i.e. the exothermic heat of hydrogenation is employed to raise the temperature of the system to the desired level. The methane content of the product gas ranges between 28-46 percent. The weight loss of the coal charge amounts to about 30 percent under suitable conditions. Effective methane yield is 20-25 percent. It is planned to subject the solid residue to oxygen-steam gasification. According to Dent (loc.cit.) the over-all thermal efficiency of the gasification process is expected to be about 70 percent. The process has until recently been studied in fixed-bed operation. A study of the applicability of fluidization technique to the hydrogenation gasification process is now underway.[12]

Another medium-pressure process is now under study in the laboratories of the U. S. Bureau of Mines.[13] Details have not been released. It is, however, stated that the process involves the hydrogenation of powdered coal in a fluidized bed at 500-1000 psi. and 840°-1110° F. Most of the hydrogen is apparently derived from the destructive distillation of part of the coal inside the reaction chamber. This evolved hydrogen is utilized for reaction with the remaining portions of the coal. Twenty-five percent of the coal is stated to be converted to methane while another 25 percent appears as distillablle oil. Fifty percent is recovered as coke and can be gasified in the usual manner, if so desired. Insufficient data are at present publicly available to establish which portion of the distillable oil is due to actual hydrogenative breakdown of the primary coal matter and which part are oils distilled in the course of the normal thermal distillation of the coal.

(End of Part V. Part VI will appear in an early issue.)

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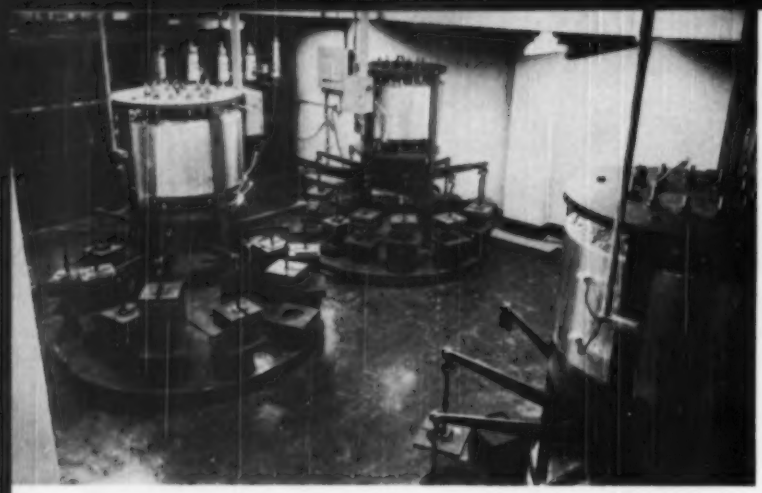
Creep and Stress-Rupture Lab Expanded



Above — Twelve-Station Units for Studying Stress Rupture Characteristics of Metals Built at Alliance, Ohio, Laboratory.

Left—Front View of Creep-Testing Apparatus Designed by Professor E. H. Norton and B&W Engineers, Recently Moved from MIT to Alliance.

EARLY attempts to investigate creep and stress rupture on an extensive scale dates back to 1926 when Professor F. H. Norton directed such experiments carried on under a joint fellowship established at the Massachusetts Institute of Technology by The Babcock & Wilcox Company and The Babcock & Wilcox Tube Company. Many alloy steels now used successfully in the petroleum refining and chemical processing fields were tested and proved with the aid of this equipment.

In recent months, the apparatus originally designed and used at MIT, was moved to B & W's new research and development laboratory at Alliance, Ohio.

Creep is measured by placing test specimens in furnaces, and keeping them under a predetermined stress and at constant temperature for long periods of time, 10,000 hours or more. Measurements are taken, usually by means of an extensometer, at regular intervals.

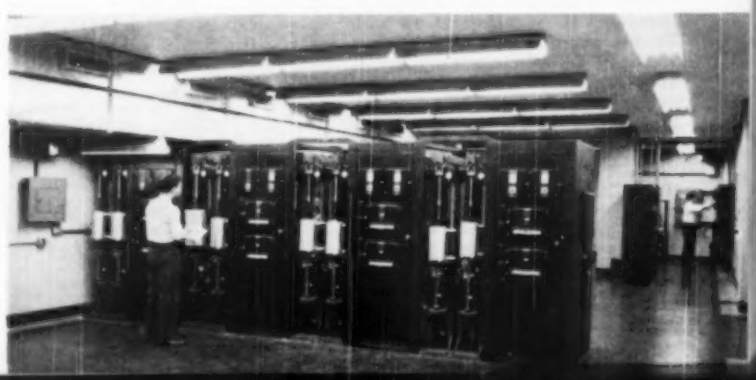
In the stress-rupture test a series of bars is subjected to static stresses of various magnitudes at the selected temperature level, and the time for fracture is determined. The stresses applied are much greater than those used for creep tests and the duration of the test may range from 100 hours to as high as 10,000 hours or more.

In order to achieve optimum accuracy, multiple-circuit electronic controls have been applied to the test units. They are actuated by the expansion of the furnace tubes, and make it possible to hold temperatures within plus or minus one degree F. up to 1550° F. A ten-inch test specimen is used and a change of less than 0.00001 inch (10 micro-inches) in its length bar can be measured.

Possibility of expansion of the framework of the testing unit, makes it necessary to keep the room temperature at a constant value—within plus or minus one degree.

New testing equipment includes 16 Baldwin-Southwark, single-station, lever-arm creep-testing machines. A maximum temperature of 1800° F., with controls holding the temperature to plus or minus two degrees, is obtainable. The gauge length of the test specimen is 3.0 inches, and the accuracy of the reading is approximately 50 parts in a million.

For the purpose of studying the stress-rupture characteristics of metals, four 12-station units have been built. The furnaces are of annular design and each contains twelve circular chambers for the specimens. The temperature of each specimen is continuously recorded, and when a specimen ruptures the change in temperature serves to record the time of rupture. Excellent temperature uniformity exists in these large furnaces, plus or minus 3° up to 1500° F. being regularly obtained.



Right—Front View of Baldwin-Southwark Single-Station, Lever-Arm Creep-Testing Machines Added to Facilities at the Alliance, Ohio, Laboratory.

Olefins in Naphthas

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Efficient distillation columns are used for making separations of shale oil into close-boiling fractions.

OLEFINS comprise one of the major groups of hydrocarbons in shale-oil and cracked-petroleum naphthas. A quantitative determination of this group of compounds may be made with reasonable accuracy by either the nitrogen tetroxide absorption or silica-gel adsorption method. Calculation of olefins from bromine number, a method used extensively in the petroleum industry, gives high results. The absolute variation on shale-oil naphthas may be as much as 35 percent. Consequently, bromine number seldom provides a satisfactory estimate of olefins when the content of these compounds is high. Sulfur and nitrogen compounds cause large errors in olefin content as determined by bromine number. Also substitution reactions and unequal distribution of the olefins throughout the boiling range probably play an important part.

An accurate determination of olefins is extremely important in processing studies of materials such as shale-oil naphtha that contain a high concentration of these compounds. In the past, the index of reliability of methods for determining olefins usually has been based on the titration of pure olefins or on the analysis of relatively simple synthetic mixtures. Little information is available[3, 6, 12, 16] on the reliability of results that may be obtained when methods so tested are applied to complex samples. This article presents a direct comparison of results obtained by applying three olefin determination methods—bromine number, nitrogen tetroxide absorption, and silica-gel adsorption—to a number of shale-oil and petroleum naphthas.

The results of the present investigation indicate that the nitrogen tetroxide and silica-gel procedures give comparable results that are substantially lower than those obtained from bromine number. Determination of olefins by difference shows that the lower results are probably more nearly correct.

A study of some of the factors involved in the bromine number determination indicated that sulfur compounds and pyrroles absorb a large quantity of bromine, that the estimation of molecular weight used in converting bromine number to percent olefins may be in error, and that substitution and addition reactions may occur simultaneously.

Comparison of Methods for Determining Olefins

Experimental Data

Ten shale-oil and nine petroleum naphthas were employed in this study. Inspection data on these samples are given in Table 1, which also contains a column for designating the type of sample. The primary naphthas were distilled from shale oils obtained by several methods of retorting. The other samples resulted from thermal or catalytic cracking processes or were blends. As this investigation was concerned primarily with shale-oil naphthas, the petroleum naphthas used were those that were easily available. Consequently, conclusions based on the analysis of these samples may not be applicable to all types of cracked-petroleum naphthas. All of the shale-oil naphthas were treated with dilute aqueous base and acid to remove tar acids and tar bases, respectively, before other analyses were performed. Olefins were determined by three direct methods based on different principles. As a check on the accuracy of these methods, the olefins also were determined by difference, as such a procedure is independent of many of the interferences encountered in the direct methods.

The methods used for the direct determination of olefins were: The bromine-number method of Johnson and Clark,[10] using the molecular-weight correlation of Mills, Hirschler, and Kurtz[14] to convert bromine number to percent olefins; the nitrogen tetroxide absorption method of Bond[2]; and the silica-gel adsorption method of Dinneen, Bailey, Smith, and Ball.[5] The method of Johnson and Clark was chosen from the many bromine-number procedures that have been proposed[7, 10, 11, 13, 15, 17, 18, 20, 21] because it is one of the most recently published and combines the advantages of several of the earlier methods. Furthermore, it forms the basis of an ASTM method[1] for determining olefins, so probably has wider circulation than most of the other methods.

The results of analyses by these direct methods are given in Table 2, which also includes results for olefins determined by difference as described later. The bromine-number procedure

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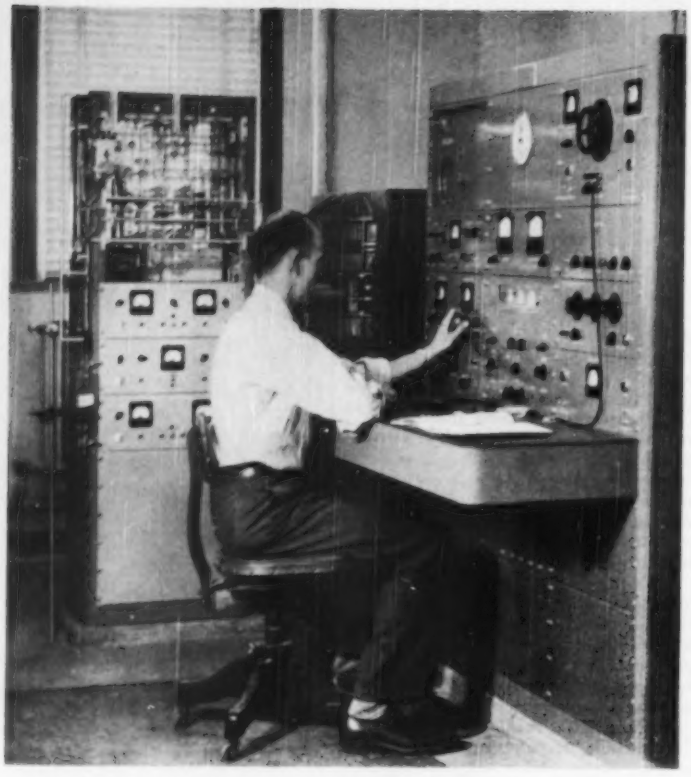


Mass spectrometer analyses are important in many studies of shale oil processing.

gives results in weight percent while the other methods give results in volume percent. However, it is felt that the direct comparison of weight and volume percentages does not introduce a significant error.

The olefins were determined by difference after the other hydrocarbon groups in the sample had been determined directly. The paraffins and naphthenes were obtained as the residue from an absorption with sulfuric acid-phosphorus pentoxide reagent.[15] The aromatics were determined both by specific dispersion[8, 19] and by aniline point.[9] These latter methods employ bromine number to correct for the presence of olefins. However, the effect of any error in the bromine-number determination would be minimized as the correction factor is less than one. Results by the above methods are given in Table 3.

Also included in Table 3 are results for saturates and aromatics by the silica-gel method. These results were not used, of course, in the calculation of olefins by difference. However, direct comparison of the results obtained for the hydrocarbon groups other than olefins should aid in locating the source of any discrepant results.

Discussion of Results

The results by the nitrogen tetroxide and silica-gel methods check within the limits of accuracy of the individual methods on 13 of the samples. The greatest variation on any of the other 6 samples is 6 percent. The results calculated from bromine number, however, are 3 to 35 percent higher than those by either of the other methods. The differences in results increase with increasing olefin content and are greater on the shale-oil naphthas than on the petroleum naphthas. This latter fact is due primarily to the presence of sulfur and nitrogen compounds in the shale-oil naphthas.

The olefins by difference check reasonably well with those by the nitrogen tetroxide and silica-gel methods, indicating that the values in the lower range shown in Table 2 are more nearly correct.

Olefins often are determined as part of a hydrocarbon-group analysis. Consideration of the results shown in Tables 2 and 3 indicates that any com-

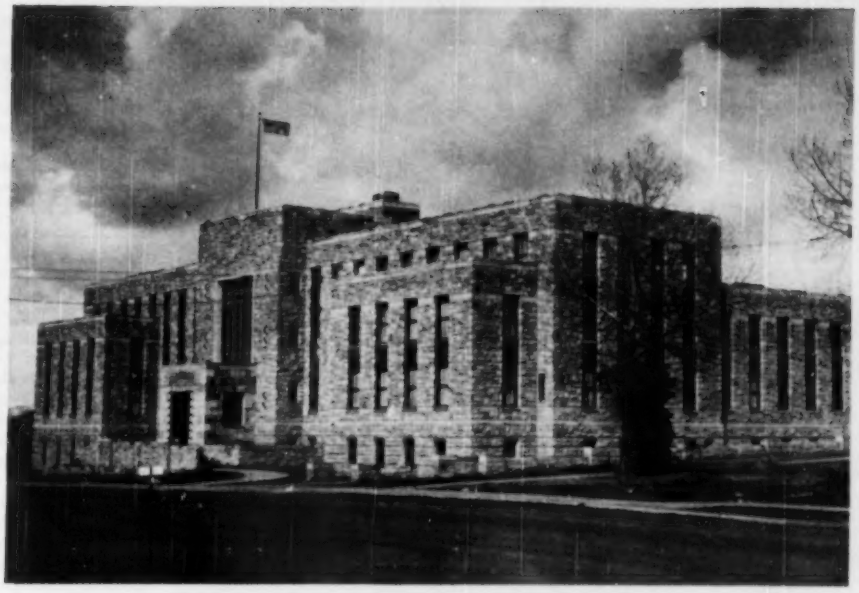
TABLE 1
Inspection Tests on Naphthas

SAMPLE		Density at 20° C.	ASTM DISTILLATION °F. at 760 mm.							Sulfur, Weight Percent	*Nitrogen, Weight Percent
Number	Type		I.B.P.	10	50	90	E.P.	Res.	Loss		
SHALE-OIL NAPHTHAS											
13	Primary	0.7958	225	271	335	416	465	1.7	0.5	1.06	0.12
70	Primary	.8001	261	304	348	429	490	1.5	1.5	.89	.18
51	Primary	.7977	130	235	312	405	418	1.4	.1	1.12	.12
71	Primary	.7910	279	307	346	412	452	1.6	.4	.94	.30
58	Primary	.7975	267	304	353	421	480	1.0	.2	1.05	.32
60	Ther.	.7690	144	208	327	398	427	1.1	1.4	.98	.13
61	Cat.	.7694	158	197	266	379	432	1.2	2.8	1.08	.10
86	Ther.	.7747	245	273	316	388	430	1.2	.8	.76	.24
88	Cat.	.7706	206	235	304	376	398	3.0	.0	.76	.23
136	Cat.	.7711	119	161	285	368	384	2.0	2.0	.76	.44
PETROLEUM NAPHTHAS											
33	Blend	.6956	117	151	192	241	304	0.5	1.0	.01	...
38	Blend	.7318	110	142	239	366	406	.9	2.1	.10	...
11	Blend	.7153	100	133	237	360	397	1.0	4.0	.03	...
10	Blend	.7184	100	132	242	366	401	1.0	3.5	.01	...
53	Blend	.7424	106	154	251	366	413	1.4	2.1	.13	...
39	Blend	.7450	109	132	215	338	367	.8	1.7	.07	...
20	Cat.	.7432	118	149	232	362	420	.5	.5	.12	...
19	Ther.	.7526	100	133	280	426	456	1.2	1.3	.30	...
7	Blend	.7363	104	135	250	401	415	1.0	6.0	.23	...

* Nitrogen was not determined on the petroleum naphthas.

TABLE 2
Olefins by Various Methods

Sample Number	OLEFINS, PERCENT			
	From Bromine Number	From Nitrogen Tetroxide	From Silica Gel	From Table 3
SHALE-OIL NAPHTHAS				
13	70	51	47	49
70	63	47	43	44
51	69	53	48	...
71	67	50	46	49
58	79	50	48	48
60	76	47	48	47
61	74	56	57	56
86	47	33	33	29
88	47	32	31	30
136	96	62	61	64
PETROLEUM NAPHTHAS				
33	16	13	13	11
38	24	18	18	18
11	26	19	20	21
10	29	23	22	22
53	37	32	26	25
39	51	37	43	37
20	51	39	40	41
19	57	45	44	41
7	59	46	47	43



Petroleum and Oil Shale Experiment Station of the Bureau of Mines. Located in Laramie, Wyoming, adjacent to the campus of the University of Wyoming, it is the center for oil shale research work in this country. Large scale pilot plant and mining experiments are carried out at the Oil Shale Demonstration Plant, Rifle, Colorado.

bination of the methods studied, other than bromine number, will give substantially the same hydrocarbon-group analysis. The use of bromine number will give a high result for olefins and a correspondingly low result for one of the other groups depending on the choice of methods. Therefore, it may be concluded that bromine number usually is not a satisfactory means of estimating olefins.

A Study of Some Factors Involved in the Determination of Olefins

The methods studied have certain inherent characteristics, such as differences in the classification of aromatic olefins, that may cause discrepancies in the results obtained. Discrepancies may also be caused by particular characteristics of the sample or method, such as the presence of interfering substances or conditions. Consequently, some of these factors were studied to estimate the extent of the errors being introduced.

Bromine-Number Method

In this method, olefins are calculated from a determination of reactivity with bromine. As this is not a direct volumetric measurement of olefins, interfering substances may react with sufficient bromine to introduce an absolute error several times their own concentration. Some possible interferences are: Sulfur compounds, nitrogen compounds, unequal olefin distribution through the boiling range, and substitution reactions. Aromatic olefins are reported as olefins and dienes will cause erratically high results, depending on the extent of conjugation.

Sulfur Compounds. Bromine numbers were determined on several sulfur compounds and on several series of synthetic samples containing sulfur compounds. The results are shown in Figure 1 and Table 4, respectively.

The curves in Figure 1, which were obtained using 0.1 gram of sulfur compound and a back titration of 5 to 10 ml. (determination of excess reagent by color as specified in the method gives erratic results), indicate that for the majority of sulfur compounds tested the bromine number varies directly over a considerable range with the amount of bromide-bromate reagent added. This variation ranges from 20 to 300 percent. Thus, within the limits of the procedure, varying quantities of bromine absorption, amounting in some cases to more than 7 atoms per mole of sulfur compound, may be obtained.

The results in Table 4 show that the experimental bromine numbers on the mixtures approximately equal those

TABLE 3
Olefins by Difference

Sample Number	PARAFFINS AND NAPHTHENES, VOLUME PERCENT		AROMATICS, VOLUME PERCENT			Olefins, Volume Percent by Difference[2]
	By Acid Absorption	By Silica Gel	By Specific Dispersion[1]	By Aniline Point	By Silica Gel	
SHALE-OIL NAPHTHAS						
13	29	28	..	22	25	49
70	34	32	..	22	28	44
51	29	27	..	..	25	..
71	32	33	..	19	21	40
58	35	33	..	17	19	48
60	36	37	..	17	15	47
61	20	20	..	24	23	56
86	58	55	..	13	12	29
88	57	56	..	14	13	29
136	14	15	..	22	24	64
PETROLEUM NAPHTHAS						
33	86	85	2	3	2	11
38	67	67	16	15	15	18
11	74	77	3	6	3	21
10	72	73	6	6	5	22
53	60	61	12	12	13	28
39	34	30	24	35	27	37
20	45	41	17	11	19	41
19	42	43	18	16	13	41
7	39	38	17	19	15	43

[1] The shale-oil naphthas were so dark that accurate refractive index values could not be obtained for the calculation of specific dispersion.

[2] The olefins were calculated using results for paraffins and naphthenes by absorption in sulfuric acid-phosphorus pentoxide reagent and an average for aromatics by specific dispersion and aniline point as inclusion of results by silica gel would, of course, tend to make the calculated olefins check those directly determined by silica gel.

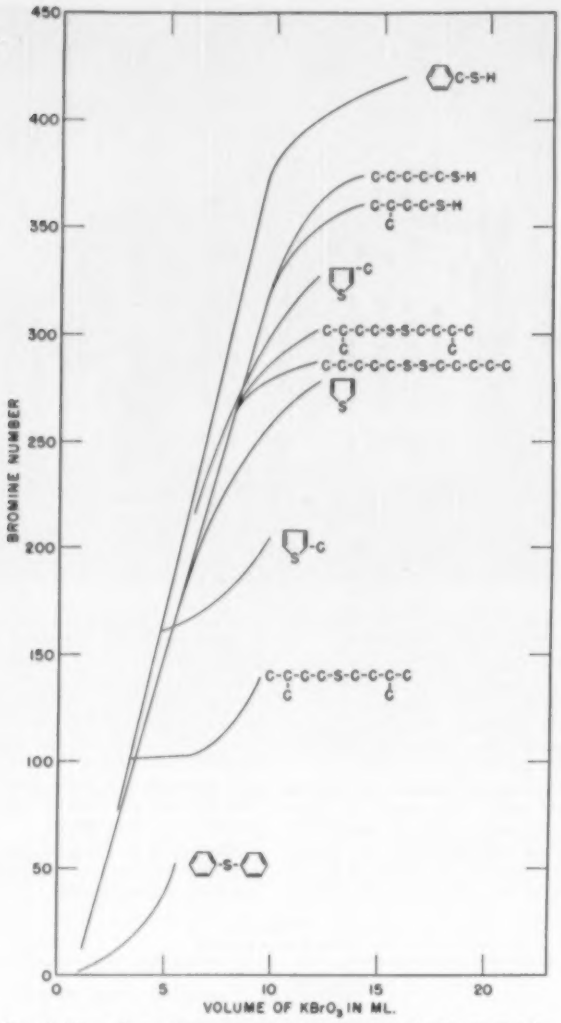


Figure 1. Effect of excess reagent on the bromine numbers of sulfur compounds.

calculated from the bromine numbers of the components. The two experimental values that are much higher than calculated probably result from the sensitivity of the sulfur compound to excess reagent. From these results it may be concluded that the presence of sulfur compounds in a sample will cause the bromine number to be erratically high and thus will introduce an error in the olefin determination. These conclusions differ from those of Lewis and Bradstreet,[13] who found that with the bromine-number procedure they used, certain sulfur compounds inhibited the reaction of bromine with olefins.

Nitrogen Compounds. An investigation similar to that made on sulfur compounds was conducted on the two types of nitrogen compounds—pyridines and pyrroles—considered to be predominant in shale-oil naphtha.[2] The results given in Table 5 show that the bromine numbers of pyrroles are extremely high, while those for pyridines are negligible. The bromine numbers were only slightly dependent on the amount of excess bromide-bromate reagent. The determination of bromine numbers on mixtures of pyrrole with diisobutylene or petroleum naphtha indicates that the presence of pyrroles in a sample will introduce an error in the olefin content several times the quantity of pyrroles present.

Olefin Distribution. The calculation of olefins from bromine number employs an average molecular weight for the olefins. Kurtz et al.[12] have stated that this molecular weight may be estimated with reasonable accuracy for cuts of 25° C. boiling range but may be in considerable error for a complete gasoline because of unequal distribution of the olefins. In order to obtain data on the magnitude of this error, each of two petroleum naphthas that had shown high results by bromine number was separated by distillation into a number of fractions according to the recommendations of Kurtz, et al.[12] Each fraction, with the exception of the first, was analyzed for olefin content by the silica-gel and bromine-number methods, with the results shown in Table 6. The olefin content from bromine number is substantially higher than that from silica gel on practically all of the fractions. Also differences in results by the two methods increase as the boiling range of the fraction increases. It is evident, therefore, that even though the olefins are somewhat concentrated, as expected, in the lower portion of the boiling range, this unequal distribution accounts for only part of the high results obtained by bromine number on these two samples.

TABLE 5
Bromine Numbers of Nitrogen Compounds

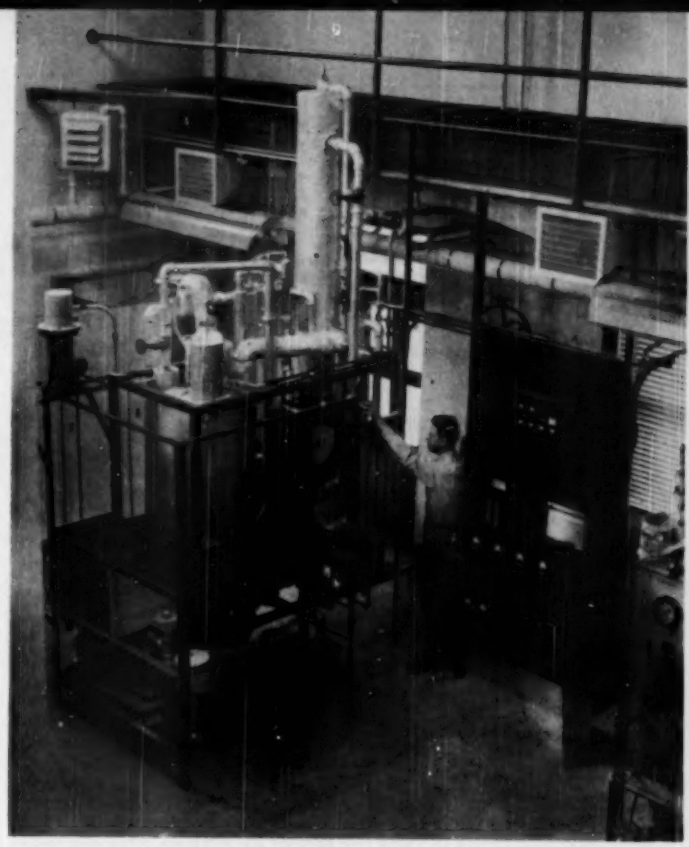
Compound	Bromine Number
Pyrrole	700
N-Ethylpyrrole	528
2,5-Dimethylpyrrole	635
Pyridine	0.0
4-Methylpyridine	.1
2-(5-Nonyl)pyridine	1.5
2,4,6-Trimethylpyridine	1.4

Substitution Reactions. Most of the procedures proposed for the determination of bromine number have aimed at minimizing substitution reactions. Obtaining the theoretically correct bromine number on several pure olefins usually has been taken as proof that significant substitution has been eliminated. However, Lewis and Bradstreet[13] and Jordan[11] have shown that in two of the modifications, the theoretically correct bromine numbers are obtained on pure olefins by an empirical balancing of addition and substitution reactions. In these cases, substitution amounted to about half the reaction.

A recent modification[6] of the bromine-number method employs an electrometric titration to maintain the excess bromine in the solution at a minimum. Bromine numbers were obtained by this method on six of the samples used in this study. On the shale-oil naphthas, the results obtained checked those by the Johnson and Clark method within experimental error, while on the petroleum naphthas, the electrometric titration gave results that were

from 1 to 5 bromine numbers lower. These differences are not large enough to affect the conclusions reached in this paper.

The possible importance of substitution reactions in the bromine number procedure was investigated using the McIlhiney procedure.[9] The results are shown in Table 7. There are large variations in the apparent addition numbers by the two methods; but the results are usually of the same general magnitude, indicating that the two methods used are somewhat comparable. However, correction of the McIlhiney results for substitution, which amounts to about one-third of the apparent addition number, gives results much lower than the Johnson and Clark values. Conversion of the corrected values to percent olefins gives results up to 20 percent lower than those obtained from the nitrogen tetroxide or silica-gel methods. It thus appears that substitution reactions may be an important factor in the bromine-number determination and that the addition reaction has not gone to completion in the McIlhiney procedure. It may be concluded that an empirical balancing of addition and substitution reactions which gives theoretically correct results on pure olefins may not be applicable to complex hydrocarbon mixtures.



Laboratory retort unit. This adiabatic retort is chiefly used to study heat requirements of oil shale retorting.

Nitrogen Tetroxide Method

This method employs a direct volumetric measurement of olefins so their concentration and boiling-range distribution have little effect on the accuracy of the determination. Aromatic olefins and dienes are determined as olefins by the method.

As there was no information on the reactions of sulfur compounds in the nitrogen tetroxide method, a number of synthetic samples containing various types of sulfur compounds mixed with different concentrations of cyclohexene and n-heptane were analyzed. The results of these analyses, which are given in Table 8, indicate that all types of sulfur compounds studied are at least partly removed. Generally, the probability of removing all or part of the sulfur compounds from a mixture containing olefin and sulfur compounds appears to be greater, the larger the olefin content.

As would be expected from these data, nitrogen tetroxide treatment of shale-oil naphtha gives an inconsistent reduction in sulfur content of 50 to 70 percent. However, the absolute error generally will be less than 3 percent for shale-oil naphthas, so that correction is seldom necessary.

Silica-Gel Adsorption Method

This method also involves direct volumetric measurement of olefins, so that their concentration and relative distribution in the boiling range ordinarily have little effect on the accuracy. However, if the olefin content is less than about 5 percent, a satisfactory olefin plateau is not obtained

TABLE 4
Effect of Sulfur Compounds on the Bromine Number

Composition of Sample, Weight Percent		Experimental Bromine Number	Calculated Bromine Number	Difference
2,8-Dimethyl-5-Thianonane (Isoamyl Sulfide)	Petroleum Naphtha			
	100	75.8 p		
1	99	74.5 r	76.1	−1.6
2	98	74.5	76.4	−1.9
5	95	75.7	77.2	−1.5
10	90	77.3	78.6	−1.3
20	80	78.8	81.3	−2.5
100		103.4		
2-Methylthiophene	Petroleum Naphtha			
	100	75.8		
1	99	74.4	76.7	−2.3
5	95	78.2	80.1	−1.9
10	90	83.5	84.3	−0.8
20	80	91.1	92.9	−1.8
100		161.2		
2-Methylthiophene	Diisobutylene			
	100	145.4		
7	93	147.4	146.5	+0.9
13	87	147.9	147.5	+0.4
20	80	148.0	148.5	−0.5
100		161.2		
2,9-Dimethyl 5,6-Dithiadecane (Isoamyl Disulfide)	Diisobutylene			
	100	145.4		
24	76	137.3	113.5	+23.8
100		11.9		
Phenylmethanethiol (Benzyl Mercaptan)	Diisobutylene			
	100	145.4		
27	73	152.2	126.8	+25.4
100		76.6		

TABLE 6

Analyses of Fractions from Two Petroleum Gasolines

Fraction Number	Cut Temp. °C. 760 mm. Hg.	Percent of Charge	Mol. Wt. of Olefins	Bromine Number	OLEFINS FROM BROMINE NUMBER		OLEFINS FROM SILICA GEL	
					Percent of Fraction	Percent of Charge	Percent of Fraction	Percent of Charge
SAMPLE 19								
[1] 1	10	10.0			50	5.0	50	5.0
2	47.9	5.0	70	120.9	57	2.8	57	2.8
3	68.3	5.2	80	120.7	60	3.1	53	2.8
4	95.3	12.0	91	107.5	61	7.3	52	6.2
5	121.3	11.6	106	95.1	62	7.2	51	5.9
6	149.4	13.2	118	80.5	59	7.8	47	6.3
7	174.2	11.3	133	64.6	54	6.1	41	4.6
8	198.9	10.4	149	52.1	49	5.1	36	3.7
9	End Point	21.3	[2]173	33.6	37	7.9	21	4.5
Total	.....	.....	.....	.....	.....	52.3	.....	41.5
SAMPLE 20								
[1] 1	10	2.4			60	1.4	60	1.4
2	47.9	12.9	70	120.1	61	7.9	59	7.6
3	65.3	9.6	80	115.1	58	5.6	52	5.0
4	95.3	18.8	91	97.7	56	10.5	48	9.0
5	121.3	16.3	104	74.9	40	6.0	38	6.2
6	149.4	16.5	118	56.7	42	6.9	32	5.3
7	174.2	8.2	133	47.0	39	3.2	28	2.3
[3]8	End Point	15.4	149	20.3	27	4.2	18	2.8
Total	.....	.....	.....	.....	.....	47.7	.....	39.6

[1] Analyses of these fractions were made on the mass spectrometer.

[2] Mid-boiling point of fraction estimated as 218° C.

[3] This fraction was taken as a bottoms, since very little material would have been obtained in fraction 9.

TABLE 7

Effect of Substitution Reactions on Bromine Number

Sample Number	Bromine Number—Johnson & Clark	Bromine Number—McIlhiney		
		Apparent	Substitution	Addition
SHALE-OIL NAPHTHAS				
70	72.0	74.0	29.1	44.9
90	89.0	78.7	28.8	49.9
61	104.0	88.5	32.8	55.7
PETROLEUM NAPHTHAS				
58	35.1	29.5	12.1	17.4
11	36.0	46.0	12.7	33.3
10	41.7	44.6	10.1	34.5
53	53.0	50.7	13.8	36.9
39	82.3	71.8	27.9	43.9
20	75.6	83.9	24.6	59.3
19	76.8	101.8	40.6	61.2
7	87.9	88.3	27.8	60.5

TABLE 8

Reaction of Sulfur Compounds in the Nitrogen Tetroxide Method for Olefins

Sulfur Compound	Relative Quantity of Sulfur Compound Removed by Nitrogen Tetroxide, Percent	
	From Mixtures[1] Containing 28 Percent Olefin	From Mixtures[1] Containing 48 Percent Olefin
Thiophene	0	42
2-Methylthiacyclopentane	0	100
(2-Methyltetrahydrothiophene)		
3-Thiapentane (Ethyl Sulfide)	100	62
3,4-Dithiahexane (Ethyl Disulfide)	100	100

[1] All mixtures contained 12 percent concentration of sulfur compound.

on the adsorptogram, and results are not dependable.

Under certain conditions silica gel may tend to cause polymerization of olefins. However, the excellent checks shown in Table 2 between the results by the silica-gel method and by difference indicate that very little polymerization has taken place on the silica gel. Also, it has been shown[4,5] that quantitative recovery of unchanged olefin may be obtained on passage through silica gel. Sulfur and nitrogen compounds that may be present are more strongly adsorbed than the olefins[5] so they do not interfere. Aromatic olefins and dienes also are adsorbed strongly so they are classed as aromatics.

Summary

The olefins in 10 shale-oil naphthas and 9 petroleum naphthas were determined by bromine-number, nitrogen tetroxide, and silica-gel methods. The last two methods gave comparable results, while those by bromine number ranged from 3 to 35 percentage units higher. The discrepancies were greater on shale-oil naphthas than on petroleum naphthas. Determination of the olefins by difference indicated that the lower results as obtained by nitrogen tetroxide and silica gel probably were more accurate than the bromine number results.

Some variation in results by the methods may be caused by differences in classification of such compounds as aromatic olefins and dienes. However, the fact that results by the nitrogen tetroxide method, which classes any molecule containing a double bond as an olefin, check those by the silica-gel method, which classes aromatic olefins and dienes as aromatics, indicates that the quantity of these compounds in the samples tested is small.

Some of the factors that might be involved in the high results obtained by bromine number were investigated. The presence of sulfur and nitrogen compounds introduces an error several times as large as the quantity present. The substantial quantities of these compounds found in shale-oil naphthas account for the higher results obtained on shale-oil naphthas as compared to petroleum naphthas. Errors in estimating the average molecular weight used in converting bromine number to percent olefins account for only a small part of the high results obtained by bromine number. Substitution reactions may play an important part in the results obtained by most bromine-number procedures. Therefore, the use of bromine number as a means of estimating olefin content is not recommended for shale-oil naphthas and should be applied with caution to cracked-petroleum naphthas unless the olefin content is low or characteristics of the sample are known.

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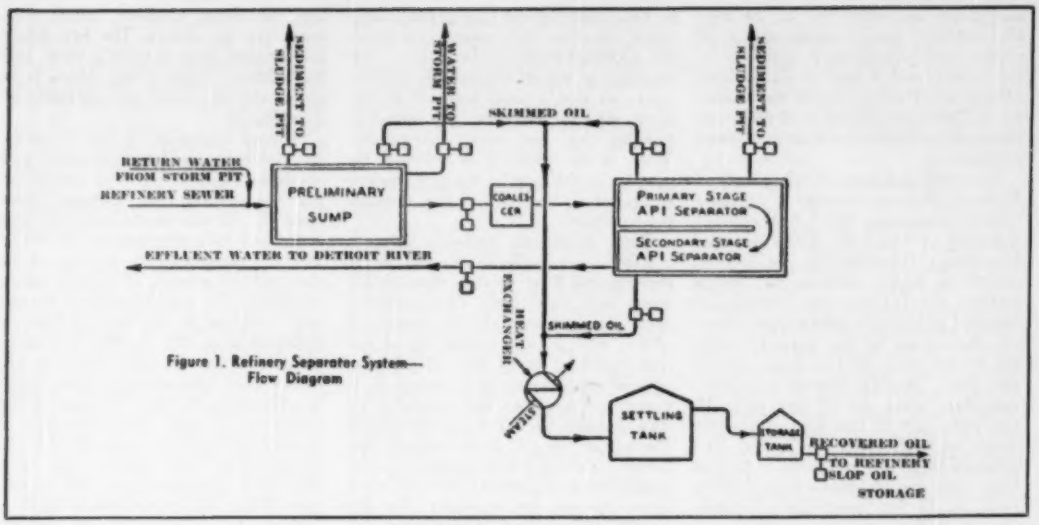

Figure 1. Refinery Separator System—Flow Diagram

Figure 1. Refinery Separator System.

Operation of Oil-Water Separator at Trenton Plant

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***IN ORDER** to prevent any possible pollution, and also to conserve potential oil losses, a decision was reached in 1946 to install an API separator and its related equipment. At that time two large baffled chambers were used as separators to remove the oil in the refinery effluent. These chambers were effecting a fair removal of oil, but they did not have sufficient capacity to process the maximum influent flows which were experienced during storms. The present separator system, in addition to the API-designed separator, is composed of a sewer sump equipped with a sediment scraper and an oil skimmer, a coalescer designed to pretreat the water entering the API separator, hay filters to obtain further clarification of separator effluent, and a storm pit for storage of excess storm waters. The oil-recovery system has performed very satisfactorily, from 50 to 70 barrels of oil being recovered daily, this without the use of chemical emulsion breakers.*

This discussion was before a group session during the 15th Mid-Year Meeting of the API's Division of Refining early this month in Cleveland, Ohio.

BY RECENT Michigan state legislation, the powers of the State Stream Control Commission have been strengthened so as to enforce control of stream pollution. Since this refinery was put onstream in July, 1929, the Michigan Stream Control Commission has worked with, and has assisted, this refinery in the problem of stream pollution. To date the refinery effluent has met the approval of the Michigan Stream Control Commission.

The International Joint Commission on Stream Pollution met in Detroit, July, 1948 and 1949, and the report of these hearings has not as yet been received.

The refinery has a capacity of 28,000 barrels of crude; and it consists of a Houdry combination crude and cracking unit, Polyform unit, Kellogg delayed-coking unit, pipe-still unit, solutizer and doctor-treating plants, a boiler house, and a grease and compounding plant.. The refinery and tank farm are situated on 160 acres. All process water and surface drainage flow through the separator.

Design

The oil-water separator consists of six distinct parts, viz.: 1) preliminary sump; 2) coalescer; 3) API separator; 4) oil-recovery system; 5) storm pit; and, 6) sludge pit. See Figure 1 for simplified flow diagram.

In general, the design of the preliminary sump was patterned after an API oil-water separator. The sump consists of an inlet distribution section, a sludge-removal section with scrapers, an oil-separation section, and a discharge-sump section. Over-all dimensions of the sump are 40 feet long, 25 feet wide, and 22 feet deep. However, the depth of the water in the oil-separation section is only 4 feet. The sump was built 22 feet deep because of the insufficient slope of the land upon which the refinery is located. A large steam reciprocating pump (14 x 14 x 16) transfers the water to the coalescer. This type of pump was used so that the water and oil would not be emulsified in the pumping operation.

A coalescer was constructed, and was put in service during May, 1949. This coalescer is an earth revetment-type pit with an inlet spider on the bottom, filled with stone and sand;

and it has an outlet line at the top. The coalescer bed is composed of 12 inches of 2-inch stone, 6 inches of 1-inch stone, and 2 feet of sharp sand (Figure 2). The capacity of the coalescer is 2700 gpm., based on 2 gpm. per square feet of effective coalescer cross-section area.

The API publication, *Disposal of Refinery Wastes*, Section 1: "Waste Water Containing Oil," 3rd edition, was used to design the API separator. The design features will not be discussed in detail, because the design follows very closely the features as outlined in the API publication. Over-all dimensions of the primary stage are 60 feet long, 18 feet wide, and 12 feet deep. Over-all dimensions of the secondary stage are 67 feet long, 18 feet wide, and 14 feet deep. The water depth in both stages is 7 feet. The primary-stage settling basin is 43 feet long, and the secondary-stage settling basin is 55 feet long. Design conditions include: water flow, 2500 gpm.; gravity of separated oil, 30° API; temperature, 70° F.

The oil-recovery system is of local design; and it consists of a 735-square-foot heat exchanger, a 3000-barrel insulated tank with 352 square feet of heating coils, and a 500-barrel storage tank.

Operation of System

The preliminary sump, in addition to receiving the sewer effluent, also accomplishes a preliminary oil and sludge separation. The sludge which settles to the bottom of the sludge-removal section is scraped by a flight scraper into two small sumps at one side of the preliminary sump. A reciprocating pump (9 x 7 x 10) takes suction from the two small sumps, and discharges into the sludge pit. Oil is skimmed periodically from the surface of the oil-separation section through a slotted pipe, and is pumped to the oil-recovery system. Water which flows into the discharge-sump section is pumped, by large reciprocating pumps, into the bottom of the coalescer. The pumps (14 x 14 x 16) are low piston-speed pumps, and do not cause emulsion formation because of excessive agitation. The water level in the discharge sump is controlled by the use of an air-purge liquid-level control system for open vessels. The liquid control operates a control valve in the steam line to the pumps.

Normally, the water flow averages 600 to 700 gpm., exclusive of rain. During unit shutdowns the flow may reach a peak of 1000 to 1500 gpm.; and during storms the flow may reach as high as 6000 to 7000 gpm. Excess water over that which may be pumped through the API separator is pumped by two large vertical-type storm pumps (total capacity, 8600 gpm.) to a storm pit (5,280,000-gallon capacity). The capacity of the API separator is 2500 gpm., so that a total load of 11,100 gpm. may be handled. To date this quantity has not been encountered. Water in the storm pit is returned, by gravity, to the inlet of the preliminary sump during low rates of flow through the separator.

Water enters the coalescer through a distribution spider on the bottom of the pit, and flows upward through the stone and sand bed. The coalescer serves two purposes: 1) the rupture of globs; and, 2) the coalescing of minute particles of oil into oil particles of sufficient size so that separation is possible. The water and separated oil flow through the outlet pipe located at the top of the pit. Tests indicate that there is a decided improvement in susceptibility to separation after the water flows through the coalescer. No difficulties have been experienced because of plugging or channeling in the coalescer bed, and the bed appears to be self-cleaning. The bed will be replaced at the end of a year's operation, for experimental purposes only, in order to determine the condition of the sand. The coalescer has made a definite reduction in the turbidity of the separator effluent.

Skimming of Oil

Water from the coalescer flows by gravity into the API separator, entering an inlet box through four 12-inch baffled pipes. Oil is skimmed from this section through a slotted-pipe skimmer. Water then flows through ten 10-inch pipes into the distribution box. Overflow from the distribution box passes downward through baskets of 2½-inch stacked raschig rings. No difficulties have been experienced because of plugging of the rings. Inasmuch as a coalescer is used to pretreat the water to the API separator, raschig rings are probably only of minor value in obtaining coalescence; but there is reason to believe that the rings improve flow distribution in the settling chamber. The water then enters the settling chamber of the primary stage of the API separator, which is equipped with a flight scraper for sludge removal, and for forcing separated oil into the oil-skimmer pipe and into an oil-retention baffle. Oil is skimmed about four times a day, and sludge is pumped three times a day. Very little sludge is removed by each pumping. Water then flows over a weir into the inlet box of the secondary stage, through a distribution box into the settling chamber, which is equipped and operated the same as the basin in the primary stage. The effluent flows into the outlet chamber, which contains two hay filters. The hay filters are changed once or twice a week, and the primary value of hay filters is in improving the visual characteristics of the effluent.

Normal operation of the oil-recovery system is to pump skimmed oil and emulsion through the heat exchanger into the settling tank. Exhaust steam heats the oil and emulsion in the heat exchanger to a temperature of 160 to 190° F., depending on the rate of oil flow and the amount of exhaust steam available. The temperature of the oil and emulsion in the settling tank is maintained at 180 to 200° F., using exhaust steam. A clean break is obtained and, periodically, clear water is withdrawn through a drain in the bottom of the tank. Oil which rises to the top of the tank overflows into the recovered-oil tank during the time that oil is skimmed from the separators. When the recovered-oil tank is full, the oil is pumped to the refinery slop tank for reprocessing. Water and sediment of the recovered oil varies from a trace to 5 percent, and averages 1.5 percent. The amount of oil recovered averages 50 to 70 barrels per day. Occasionally a layer of coke-stabilized emulsion forms in the settling tank, which will not break even though the emulsion is heated to 210 to 212° F. Tests indicate that this emulsion will not break with the use of chemical-emulsion breakers. With existing facilities, the emulsion cannot be introduced into an electrolytic crude-desalting unit; therefore, it is withdrawn from the tank, and is pumped to the sludge pit.

Consolidation of slop oils and emulsions has proved of benefit to the operation of the separator. By the collection of all slop and emulsion in one tank, it was found that the more troublesome oils and emulsions were not being introduced to the sewers. Inasmuch as one man operates the slop-collection tank, better control is obtained. The oil is pumped into the oil-recovery system for treatment and breaking of emulsions. Crude tank bottoms have also been disposed of in a similar manner.

Sludge removed from the separators is pumped to a 300,000-gallon sludge pit. Solids (clay, silt, and coke) settle to the bottom of the pit, and water is drawn through a swing line into the adjacent storm pit, to be returned to the preliminary sump as flow conditions permit. When the sludge pit was full, a clam-shell crane was used to load the sludge into dump trucks. The sludge was then dumped into an area to be filled with waste dirt. It should be noted that this process is not a permanent solution for disposal of

sludges, as the sludge still contains sufficient quantities of oil and water to prevent indiscriminate dumping. Laboratory tests indicate that it is very difficult, even impossible, to break the emulsion and obtain a solid satisfactory for disposal. However, tests have indicated that the sludge may be broken by the use of a precoat filter if it is treated as it is removed from the separator.

Semi-Annual Cleanout

It has been necessary to shut the entire separator down about once every six months for cleanout and to make any necessary repairs. Soil conditions at the Trenton refinery cause a large amount of fine yellow clay to be washed into the sewers during storms. A portion of the coke produced in the Kellogg delayed-coke unit is very fine; and, of the part which is unavoidably washed into the sewers, 60 percent will pass a 200-mesh screen. Over a period of time silt and coke settle in those sections of the separator which are not provided with flight scrapers or other means of sludge removal. Repairs to equipment have all been minor.

Factors Affecting Operation of Separators

In all probability the type of oil in the influent is the most important factor in the removal of oil by gravity-type separators. No difficulty is experienced in separating light oils; because the greater the difference in gravity between the oil and water, the greater is the ease of separation. Emulsions of the oil-in-water type (milk emulsions) will not separate, because the gravity of the emulsion is essentially that of water. Emulsions of the water-in-oil type vary in characteristics—some being very light, and others approaching the density of water. This variance is due to the amount and type of oil in the emulsion, and to the conditions under which the emulsion is formed. Heavy oils have been encountered in the refinery ranging in gravity from 3 to 22° API, and some emulsions have gravities as low as 1 to 2° API.

There are two main sources of sludge: clay silt, and coke. The silt and coke absorb oil in the sewers, and in some cases the individual particle has an apparent density approximating that of water, and, therefore, will not settle out in the separator. Also, fine solids tend to stabilize emulsions.

Certain chemical solutions, such as concentrated caustic, will stabilize emulsions. Untreated sewage will carry oil through a separator, whereas treated sewage will not. However, at this refinery such solutions are not discharged into the separator system.

Changes in Refinery Operations

An educational program was conducted in conjunction with the Refinery Conservation Committee to reduce the amount of oil and water which enters the separator. At one time this program reduced the normal water flow from 1300 to 800 gpm., and recovered oil from 110 to 80 barrels per day. A study was made of the sources of oil entering the sewers, and in this study appropriate operators were given training in the proper operation of equipment to reduce the amount of oil entering the sewers.

At the Kellogg coke unit, during the drum-switching and watering-down period, a large quantity of emulsion was formed due to the quenching of drum vapors with water in a blowdown stack. Water, oil, and emulsion were collected in a blowdown pit and, due to the size of the pit, it was necessary to draw off water each day. The water drawn off was a "milk" water emulsion and, therefore, could not be handled efficiently in the separator. A system was devised whereby blowdown-pit water is recycled to quench the vapors, thereby reducing the amount of "milk" water which enters the separator.

Periodically an extremely heavy oil (gravity, 1° to 5° API) would collect in the bottom of the blowdown pit. This oil is pumped to a collection tank, and is mixed with other lighter recovered oils for rerunning.

Higher retaining walls around the coke drums were built in order to confine the coke and water in a small area, so that coke fines would not be washed into nearby sewers. Also, a special sewer and sump were installed at the Hydrobin area in order to prevent the coke and water spillage from entering the refinery sewer system. Coke-cutting crews were given additional instruction in the operation of the coke-cutting hydraulic system, so that water would not be dumped into the sewers at various times during the cutting operation.

Conclusion

Since the API separator was installed in 1946, the quality of the effluent has been improved. In a survey made in 1949, the Michigan Stream Control Commission gave the rating of control as "adequate" for the refinery effluent. However, after thorough studies of the present separator and of the factors affecting separation of oil and waste water, we feel that further improvement in the separator effluent can be made. This can be achieved by improving the quality of the influent to the separator. Therefore, plans are being made to install auxiliary separators at the units in order to remove those oils which are difficult to separate.

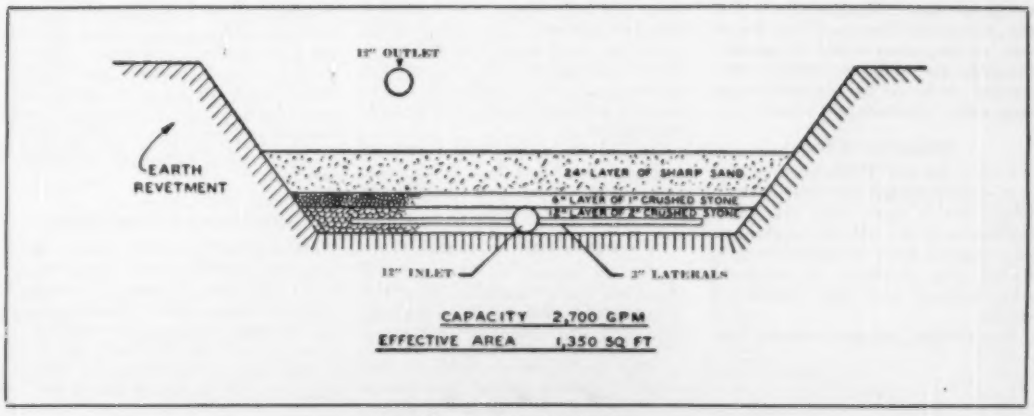

Figure 2. Sectional Elevation of Coalescer

COMPARED METALS	Approx. melting pt. °F.	Weight in pounds per cu. in.	Weight in pounds per cu. ft.	Weight ratio**	Expansion Ratio**	Thermal conductivity ratio**	Specific heat ratio**	Tension Modulus in Millions
Magnesium*	1204	.063	109	1.00	1.00	1.00	1.00	6.3
Beryllium*	2345	.066	114	1.05	0.46	1.00	2.10	37
Aluminum*	1215	.098	170	1.56	0.92	1.40	0.86	10
TITANIUM*	3300	.164	284	2.60	0.33	0.19	0.50	17
ZIRCONIUM*	3200	.23	398	3.65	0.19	0.05	0.26	11
Plain high chromium stainless steels	2750	.28	485	4.45	0.42	0.26	0.43	29
Plain carbon and low alloy steels	2700	.286	490	4.50	0.46	0.51	0.43	29
Austenitic stainless steels	2600	.29	500	4.58	0.67	0.17	0.47	28
Nickel*	2650	.32	560	5.13	0.50	0.58	0.42	30
Copper*	1980	.32	560	5.14	0.63	2.50	0.37	16
MOLYBDENUM*	4760	.37	650	6.00	0.19	0.92	0.24	50
Tantalum*	5400	.60	1050	9.70	0.25	0.34	0.14	27

*Commercially pure metals.

**Approximate ratio (near 70°F) Magnesium = 1.

THE NEW METALS—

Molybdenum, Titanium And Zirconium

THE commercially available materials are not always adequate for the severe high temperature or corrosive conditions which are encountered more and more in present day technology. Progress in the development of the metals molybdenum, titanium and zirconium has been stimulated because of this need. Molybdenum and titanium are now obtainable in limited quantities and shapes, but zirconium research has not as yet advanced to the point of making that metal readily available. Techniques for producing and fabricating these metals are progressing rapidly, so that within the next few years they should take an important place in industry alongside the other so-called "special metals," such as the stainless steels, super-alloys, tantalum and others.

Limitations of Each

Each of the new metals has properties that make it valuable for certain applications but, of course, each also has its limitations. In the table above, the common characteristics of molybdenum, titanium and zirconium are compared with those of nine other well-known metals.

Molybdenum, which is available commercially,[1] is particularly noteworthy because of superior strength at temperatures above 1900° F. as compared with the best present-day metals, and for its high modulus of elasticity. It is probable that molybdenum alloys of even more desirable properties will be announced before long. The increased availability of sheet, forgings and fairly massive parts of high molybdenum alloys will enable us to gain the increased efficiency of many processes at high temperatures.

Molybdenum shows outstanding resistance to hydrochloric acid. A decided limitation, however, is the severe oxidation of the metal at red heat and above. Surface coatings that will overcome this drawback are being intensively studies and will probably provide a solution to the problem.

Welding of molybdenum presents problems due to its high conductivity and melting point, and development work in this field is required.

Future Like Aluminum

Titanium appears to have a future paralleling that of aluminum. It is more abundantly available in the earth's crust than many other commonly used metals. By alloying or cold working, its tensile strength can be increased to 150,000 psi. or more. It is relatively light (about 67 percent heavier than aluminum, but over 40 percent lighter than the stainless steels).

The metal is weldable and does not present any unusual fabrication problems. Corrosion resistance is excellent, approximately equal to that of the stainless steels, which makes titanium a highly promising material for industrial atmospheres and possibly for salt air applications. Titanium development is proceeding rapidly and one large metal producing company has announced the availability[1] of limited quantities of titanium in sheet and other forms.

Early Stages for Zirconium

Zirconium development appears to be in its early stages and while the metal is available for special small scale uses, it is not being produced in commercial quantities at the present. The metal is 20 percent lighter than plain carbon and stainless steels but is about 40 percent heavier than titanium. It is superior to titanium and the stainless steels in corrosion resistance to many media. Future applications appear excellent in view of its high strength, relatively light weight and excellent corrosion resistance, and these attractive properties should spur research and development looking to the production of zirconium on a commercial scale.

Reference and Acknowledgment

[1] Names available from Tempil® Corporation, 132 West 22nd Street, New York 11, which company's "Tempil' Topics," Volume 5, No. 2, is the source for the above discussion.

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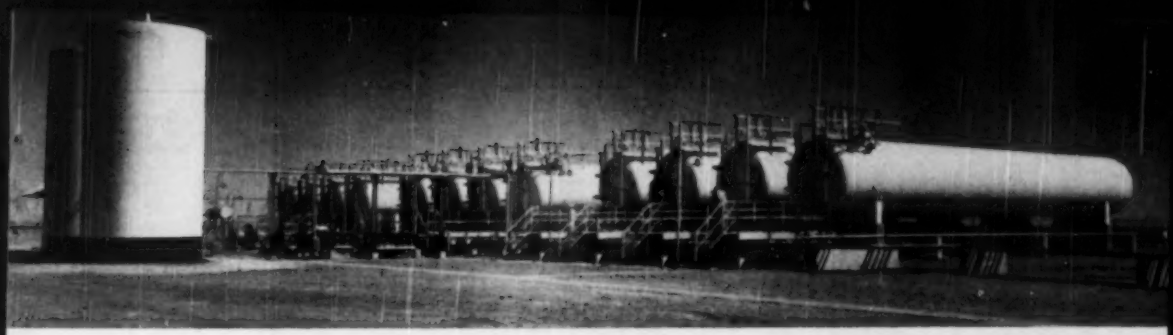


Propane Storage Tanks at Levelland, Texas, Gasoline Plant. This plant is being operated for its 11 owners by Stanolind Oil and Gas Company.

New Joint-Operation Gasoline Plant Opened Near Levelland In Hockley County, Texas

J. E. McCOLLUM, J. M. COOK, E. W. KILGREN
Standard Oil and Gas Company, Tulsa

THE LEVELLAND gasoline plant, which recently went into operation in West Texas, is an outstanding example of gas conservation. Ten companies and two individuals are joint owners of the plant. They are Stanolind Oil and Gas Company, The Texas Company, Magnolia Petroleum Company, Mid-Continent Petroleum Corporation, Tide Water Associated Oil Company, The Superior Oil Company, Sun Oil Company, Kewanee Oil Company, Skelly Oil Company, Maracaibo Oil Exploration, Roy O. Cobb and Ed H. Watson. Stanolind is the plant operator.

The Levelland field, discovered in 1945 by The Texas Company, is located in the west central part of Hockley County, Texas, immediately northeast of the Slaughter field. Cumulative oil production to date is approximately 23,400,000 barrels. Levelland crude is black, sour, and has an Api gravity of 31°.

TENTATIVE plans were made during 1947 for installing a natural gasoline plant to serve Levelland field; but since rapid development caused numerous changes in the areal extent of the field, final plans were not crystallized until February, 1949. In order to eliminate flaring of gas as soon as possible, the plant was constructed in two phases. The initial phase consisted of installing facilities for gathering, compressing, and sweetening gas for sale to El Paso Natural Gas Company. Plant construction was started on April 4, 1949, the initial phase completed on November 11, 1949, and specification products were produced on January 11, 1950. The Levelland gasoline plant is located adjacent to the Santa Fe railroad about three miles west of the town of Levelland.

The plant is designed to process 40 million standard cubic feet daily. When processing this volume of gas having the composition shown in Table A, design daily recovery of liquid products is approximately 30,000 gallons of propane, 40,000 gallons of butane, and 60,000 gallons of debutanized gasoline.

The plant employs a conventional process cycle, except that it uses only one absorber. All of the plant vent gas is recompressed in the third stage compressors and recycled to the absorber. This cycle was selected in order to reduce plant utilities to a minimum and to deliver all high BTU flash vapors to sales. The high nitrogen content of the inlet gas makes this latter requirement necessary in order to meet sales gas specifications.

Field System

The field gas gathering system is designed to collect gas from field separators operating at 10 psig., and deliver it to the gasoline plant at a pressure slightly above atmospheric. The plant gathering system extends from the town of Levelland westward for about 16 miles to the town of Whiteface. It consists of five main lines with branch lines connecting the well batteries. No residue return system is provided since most operators utilize electric power for pumping.

Gas Handling Facilities

Figure 1 presents a flow diagram of the gas handling facilities, which are comprised of the field gas compressors, the H_2S removal system, and the residue gas dehydration system.

The plant field gas compressors (Figure 1) consist of nine 1200-hp. (sea level rating) V-12 four-cycle gas-

TABLE A
Design Gas Composition

COMPONENT	Mol. Percent
Nitrogen	11.42
Hydrogen Sulfide	0.07
Carbon Dioxide	0.82
Methane	64.15
Ethane	10.68
Propane	5.55
Butanes	3.29
Pentanes	2.00
Hexanes	0.75
Heptanes and Heavier	0.97
	100.00

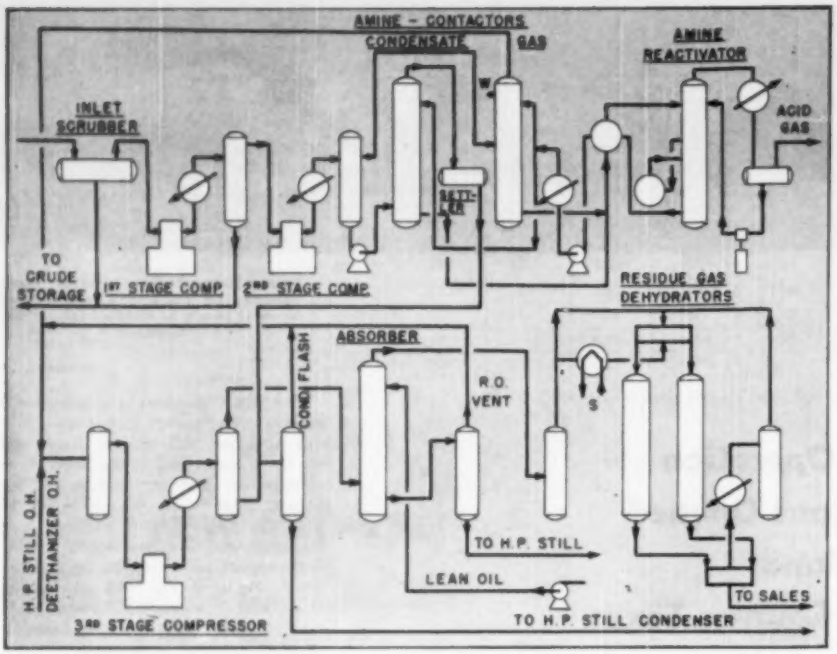


Figure 1. Gas-Handling Facilities at Levelland, Texas, Gasoline Plant.

engine-driven units designed to compress approximately 40 million cubic feet per day from 15.0 psia, to 713 psia., and to compress approximately 4 million cubic feet per day of cycle vapors from 198 to 713 psia. Each machine is equipped with three stages of compression.

Field gas enters the plant through a 12-foot x 40-foot horizontal scrubber. Gas from this scrubber flows to the compressor first-stage suction header at essentially atmospheric pressure, and is compressed through two stages to approximately 190 psig. The second-stage discharge gas is cooled and passed to a scrubber before flowing to the acid gas removal system. Sour gas and condensate from the second-stage scrubber are contacted countercurrently with amine solution in separate contacting towers. The foul amine solutions from these towers are combined and heat exchanged with hot re-activated amine solution and enters the re-activator tower at a point near the top. Overhead vapor from the re-activator, consisting of acid gas and steam, passes through an overhead condenser which condenses most of the steam. This condensate is returned as reflux to a bubble-cap tray located in the top of the tower. Reboiler heat for stripping acid gas from the foul amine solution is supplied by exhaust steam from process pumps. The hot re-activated amine solution passes from the bottom of this tower through the heat exchangers, previously mentioned, and is then pumped through a cooler to the top of the contacting towers.

Sweet gas from the amine contacting tower flows through a residue scrubber and joins the recycle vapors at the inlet of the third stage of compression, where it is compressed from approximately 185 psig. to the absorber operating pressure of 700 psig. The third-stage discharge gas is cooled and passed through a scrubber before entering the absorber. Condensate from the third-stage scrubber is combined with the sweetened condensate from the acid gas removal system and flashed. Vapors from this flash are recycled to the third-stage compressor suction and the condensate flows to the high-pressure still condenser. Residue gas from the absorber is dried in solid desiccant type dehydrators to meet sales gas specifications. All residue not used for plant fuel is sold.

TABLE 1
Levelland Tower Schedule

SERVICE	Size	Normal Operating Pressure Psig.	No. of Trays
1. Condensate Amine Contactor	20'x30'-0"	255	Packing
2. Amine Contactor	6'-0"x47'-0"	185	20
3. Amine Reactivator	5'-6"x51'-0"	12	Packing
4. Absorber	5'-6"x55'-0"	700	25
5. Residue Gas Dehydrators (2 Units)	4'-6"x28'-0"	685	
6. High Pressure Still	4'-6"x36'-0"	205	22
7. Low Pressure Still	4'-6"x36'-0"	45	22
8. De-ethanizer	3'-6"x38'-0"	455	25
9. Depropanizer	3'-6"x78'-0"	210	35
10. Caustic Contactor	3'-6"x30'-0"	100	Packing
11. Caustic Regenerator	2'-0"x30'-0"	7	Packing
12. Debutanizer	4'-0"x68'-0"	55	30
13. Propane Driers (2 Units)	20"x 8'-0"	190	
14. Copper Chloride Treaters (2 Units)	6'-0"x12'-0"	50	

Distillation and Fractionation System

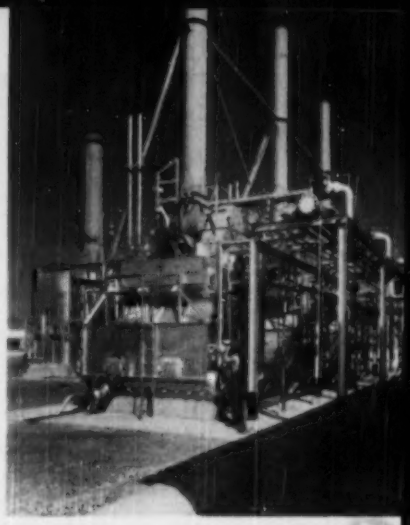
Figure 2 is a flow diagram of distillation and fractionation systems. A two-still system was selected for the plant to reduce stripping steam requirements. Sufficient stripping is accomplished in the high-pressure still to permit total condensation of the low-pressure still overhead. Design lean oil circulation of the absorber is 278 gpm. for a 40 million scfd. processing rate.

Rich oil from the base of the absorber flows to a vent tank from which flashed vapors are returned to the suction of the third-stage compressor. The rich oil from this tank is heated to 325° F. by heat exchange with hot lean oil from the low-pressure still and flows to a second vent tank. The hot vapors from this tank enters the high-pressure still on the third tray above the feed tray. The hot rich oil flows through a direct fired heater, where it is heated to 450° F. and enters the high pressure still on the twelfth tray. Rich oil passes down through the stripping section of the still countercurrent to steam which is introduced to the bottom of the still at a design rate of 750 pounds per hour. Flashed vapors from the feed and stripped

vapors enter the upper section of the still, where vaporized lean oil is washed back by reflux returned to the top tray at a design rate of 39 gpm.

Partially stripped rich oil enters the low-pressure still in the twelfth tray and is completely stripped by steam entering the bottom of the tower at a design rate of 1875 pounds per hour. Prior to entering this still, all stripping steam passes through the oil reclaimer wherein a small side-stream of lean oil is steam-distilled to eliminate high-boiling materials. Reboiler heat for the oil reclaimer is supplied by a portion of the still feed. Lean oil from the low-pressure still, following heat-exchange with rich oil feed to the high-pressure still, is cooled, and circulated over the absorber.

Flashed vapors from the feed, together with stripped vapors, pass through the upper section of the still countercurrent to reflux, which is returned to the top tray at a design rate of 34 gpm. Overhead vapors from the low-pressure still are totally condensed, and the overhead make from the still is pumped to the inlet of the high-pressure still reflux condenser where it joins the overhead vapors from the high-pressure still. From this condenser the raw-make stream, consisting of high-pressure and low-pressure still overhead products and condensate from the condensate flash tank, flows to the de-ethanizer feed tank where noncondensed vapors are separated and returned to the suction of the third-stage compressor.



Stanolind worker at Levelland gasoline plant opens the feed water valve on a boiler.

The raw-make stream is heat exchanged with the depropanizer bottoms and then preheated with steam to 195° F. before entering the de-ethanizer. Non-condensable overhead vapors are recycled to the suction of the third-stage compressor. De-ethanizer bottoms flow to the depropanizer where commercial propane is produced overhead and sent to the propane treating unit. Depropanizer bottoms, following heat exchange with the de-ethanizer feed, are cooled and sent to the mercaptan removal system. After treatment, the depropanized liquid is heat-exchanged with the natural gasoline product and preheated with steam to 190° F. before entering the debutanizer. Commercial butane is produced overhead from this column and flows through a product cooler to storage. Natural gasoline is produced as bottom product, and after heat-exchange with the debutanizer feed, flows through a cooler to the copper chloride treaters.

Product Treating Facilities

Figure 3 presents flow diagrams of the product treating facilities, which are comprised of the mercaptan removal system, the propane treating system, and a copper chloride treater.

The high mercaptan sulfur content of the Levelland Field gas makes it impractical to treat the gasoline in a conventional stationary-bed copper chloride treater without pretreatment to reduce the mercaptan content. In the Levelland plant, a regenerative caustic wash serves this purpose. The depropanizer bottoms pass upward through a contactor, packed with Raschig rings, countercurrent to a 10.0 per cent sodium hydroxide solution,

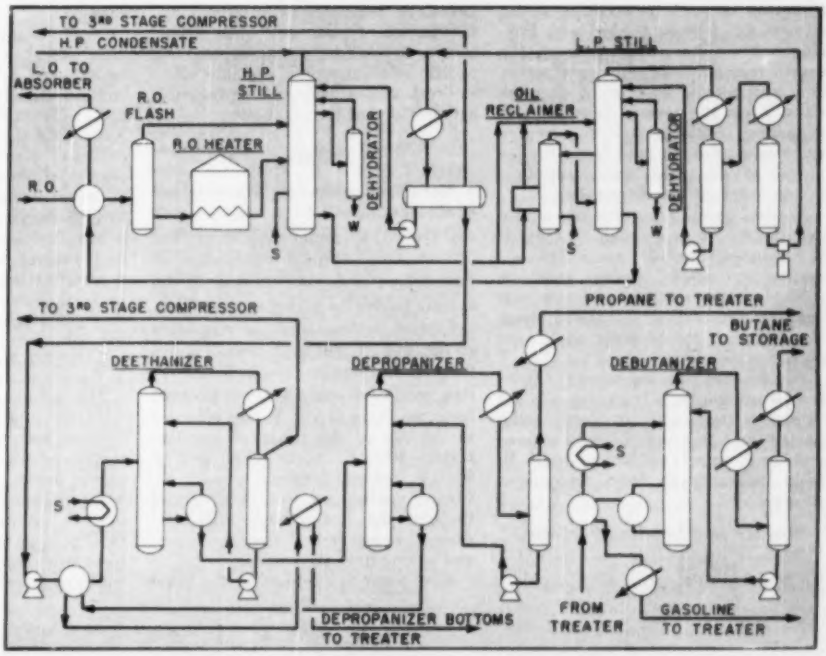


Figure. 2. Distillation and Fractionation System at the Levelland Gasoline Plant.

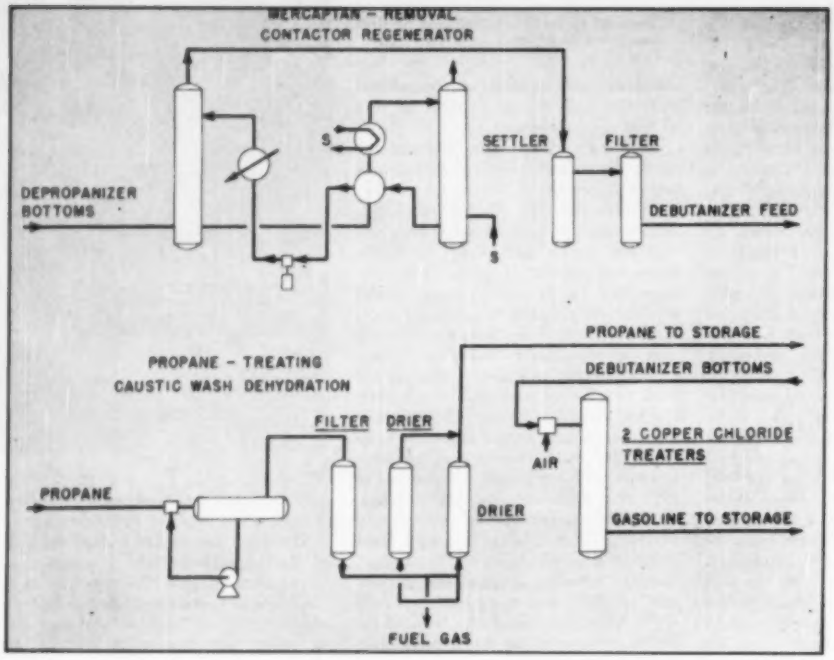


Figure 3. Flow Chart of Product Treating, Gasoline Plant at Levelland, Texas, Opened late in April.

which is circulated at a design rate of 10.4 gpm. This caustic circulation reduces the mercaptan sulfur content of the depropanizer bottoms to a point where it can be satisfactorily treated in fixed-bed copper chloride treaters. Spent caustic from the bottom of the contactor is regenerated by steam stripping in a tower packed with Raschig rings. The overhead from the caustic regenerator, consisting of steam and mercaptans, flows to a disposal stack. From the caustic contactor, depropanizer bottoms flow to a settler and thence through sand filters for removal of entrained caustic solution before entering the debutanizer.

Cooled gasoline product from the debutanizer flows through two fixed-bed copper chloride contactors operating in parallel, before going to storage. This treatment converts the remaining mercaptan sulfur content of the gasoline to odorless and noncorrosive disulfides.

Commercial propane overhead from the depropanizer is caustic washed to remove traces of sulfur compounds, passed through a sand filter to remove entrained caustic solution dried in solid desiccant-type driers, and run to storage.

Storage and Loading Facilities

Product storage has been installed for approximately five days' production when processing 40 million cubic feet per day. There are twelve 715-barrel capacity storage tanks, four each for gasoline, butanes, and propane. A 100-barrel elevated tank is provided for domestic treated water storage, and storage is also provided for 250 barrels of domestic raw water and 10,000 barrels of plant well water. Other storage is provided for absorption oil, caustic solution, amine, and lube oil.

Truck and railway loading facilities are provided at the plant site.

Utilities

Steam and water requirements are held to a minimum by: 1) using a two-still system; 2) minimizing absorption oil circulation through elimination of reabsorber; and, 3) utilizing air-fin coolers for engine jacket water service.

Precess cooling water is circulated at the rate of 400 gpm over a 2-cell induced draft cooling tower. Under design conditions, cold water is pumped from the basin at 78° F. and returned to the top of the tower at approximately 109° F. About 3000 gpm of 95° F. water, previously used for various cooling services, is circulated through the low-pressure still condenser, amine re-activator condenser, and engine lube oil coolers.

Raw water is supplied to the plant by one 75-gpm. and two 150-gpm. wells located adjacent to the plant fence.

Electric power is furnished by three 250 kw., 440-volt, three phase generators, each driven by a 370 bhp. (nominal sea-level rate) 4-cycle gas engine.

Steam is supplied at 275 psig. by three package-type 3-drum boilers. All boilers are normally fired, but two boilers can handle the plant load of approximately 25,000 pounds per hour, for a short period of time. High pressure steam is used for prime movers, for stripping steam in the high-pressure still, and for regeneration of driers. All other process heat is supplied with exhaust steam, which is furnished mainly by the turbine driving the lean oil pump.

Buildings

There are a total of eight buildings in the plant area. These include a 30 x 312-foot compressor building; a 50 x 90-foot shop and warehouse; a 40 x 80-foot generator building; an operator's shelter, garage building, fire pump house, hose cart house, and water treating building. Pumps are not housed, but are placed adjacent to the facility they serve. All buildings are of truss-type construction with roof and walls of galvanized corrugated iron.

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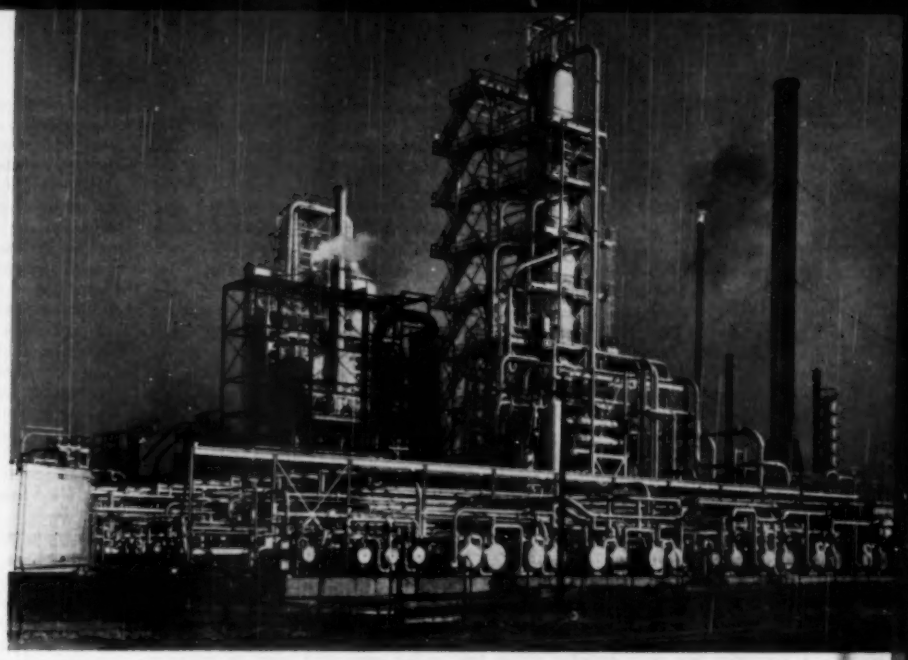


Figure 1. Catalytic cracking units such as the one shown here generate large quantities of high pressure-high temperature by-product steam. Considerable savings in refinery power plant costs can be made when this steam is used in a well-balanced power-process cycle.

—Photo Courtesy of Standard Oil Company (New Jersey).

Power Plants For Modern Refineries

Part III

TYLER G. HICKS
Hicks Associates, New York

THE discussions in the first two parts of this series emphasized the economic importance of refinery power plants and the power-process balance. Attaining low cost production is a function of both design and operation, but the initial step toward savings must be taken and carried through in refinery design. Economical utilization of waste heat in hot oil streams, flue gases, and some overhead vapors present many opportunities for refinery designers to reduce initial costs of steam generating equipment and annual operating costs. Power generation, the driving of pumps, blowers, fans and other auxiliary equipment by natural gas expansion turbines or combustion gas turbines present many other chances for savings in initial and operating costs. When the proper balance between production and power generation is obtained, operating costs will indicate the advantages of good design.

Refinery use of waste heat equipment has grown with the number of operations performed. Today waste heat is hunted down, trapped, and made to do work. Generation of steam at 450 psi., 450° F. with waste heat is now common practice in catalytic cracking units. This pressure and temperature is almost double that of the steam produced by older refinery power plants. Tube still flue gases with temperatures of about 1100° F. now generate from about 5000 to 70,000 pounds per hour of 450 psi. steam in specially designed waste heat boilers. Oil heated steam generating units which replace conventional water cooling equipment will generate 5000 or more pounds of steam per hour at pressures of about 150 psi. Each of these units, however, must be applied with the power plant heat balance in mind because erroneous application can be extremely wasteful.

WASTE HEAT boilers and generation of steam from process operations are discussed in this, the final installment of Mr. Hicks' current series. The first two parts (December, 1949 and January, 1950) dealt with the economic importance of refinery power plants and the power-process balance. Design, it is emphasized, is where low cost production starts and it is this phase that is given further attention in Part III.

Flue gases from regenerators in catalytic cracking units pass through a cyclone separator before leaving at high temperature. Heavy catalyst particles are removed from the gases and they pass to the regenerator exit line. This line conducts them to the flue gas cooler where waste heat is recovered by generating high pressure steam from water fed to the cooler. Low-temperature flue gases then pass through an electrostatic precipitator where fine catalyst particles are removed. Catalytic units generate 20,000 to 60,000 pounds per hour of 450 psi. by-product steam; the lower capacity is for a 10,000-barrel-per-day unit and the higher for a 15,000-barrel-per-day unit. Use of this steam is at the discretion of the designer.

It should be recalled that high-pressure steam is excellent for process heating uses. As a result it is often possible to improve the power-process balance by use of by-product steam for process heating instead of power plant steam. This follows from the fact that every extra pound of power plant steam requires more boiler capacity, piping,

insulation, fuel, and controls, which means a larger initial investment and higher operating and maintenance costs. Extensive use of by-product steam for process reduces initial power equipment costs and improves plant economy.

Waste heat boilers using tube still flue gases are of various types, depending to a great extent upon the oil heater design. Convection type waste heat boilers remove heat from oil heater flue gases after the gases have passed the radiant-heat tube section. With this arrangement the oil stream receives a major portion of the heat generated in the heater. The remaining heat which would be discharged to the atmosphere is absorbed by the feedwater. One typical arrangement of a convection type waste heat boiler is shown in Figure 2A. By using a pump to produce circulation through the convection heater coil, the steam generating capacity is increased considerably. Hooking one or more exchanger type generators to the boiler drum further increases generating capacity.

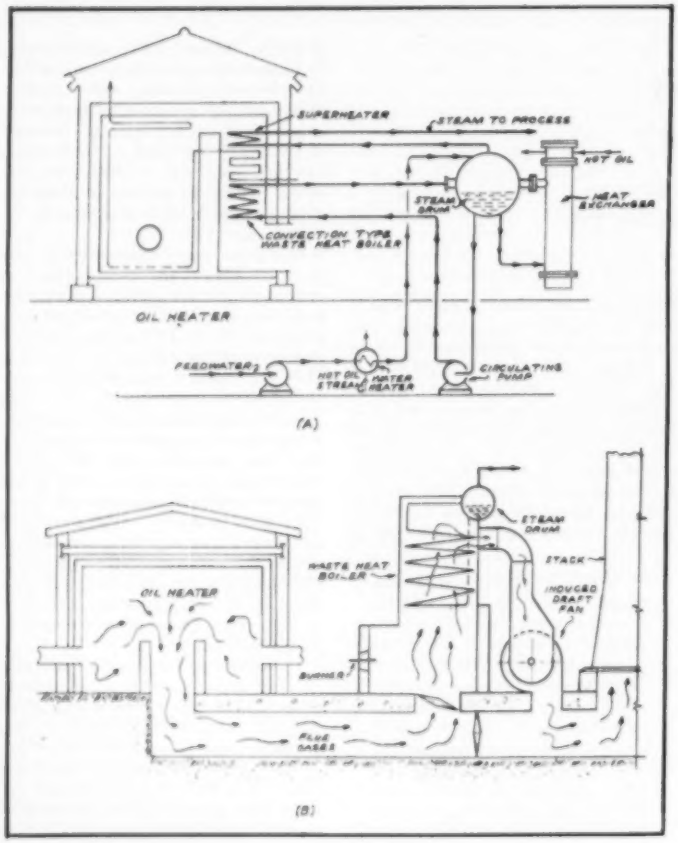
Separate waste heat boilers, Figure 2B, are equipped with an induced draft fan which draws the flue gases from the bottom of the oil heater. They pass over the boiler tubes and are discharged to the stack. A by-pass damper permits shutting down the boiler whenever necessary and an auxiliary burner permits steam generation during heater shutdown or periods of small flue gas flow.

Good application of waste heat boilers requires some study. For instance, during shutdown of an oil heater fitted with a convection type waste heat boiler, steam generating capacity is lost. This reduction in steam flow might seriously affect production in another part of the plant. By locating a power plant process header nearby, a temporary steam supply can be obtained. Alternatively, steam produced by other waste heat boilers can be used if proper outlets are fitted in the piping.

Hot oil and reflux heated steam generators decrease initial boiler, cooling water system, and fuel system investments. Process equipment costs increase somewhat but the lowered power plant and cooling system investment and operating costs frequently make hot oil heaters feasible. They are especially applicable in vacuum distillation and cracking installations. In many cases these steam generators are limited as to capacity and pressure, but these characteristics do not often hinder use. There are so many operations to which low pressure steam can be applied that there is seldom a refinery where hot oil or reflux heaters are not economically justifiable.

Waste heat generation of steam in the American application of the Fischer-Tropsch process for synthetic gasoline manufacture is an excellent example of how refiners have tried to improve the power-process balance. The waste heat boiler, besides generating steam, acts as a cooler of the synthesis gas. Sythesis reactors can generate about 350,000 pounds per hour of 650-psi. steam when producing 1000 barrels per day of synthetic oil. Approximately two-thirds of the process steam requirements of synthetic gasoline plants can be supplied by waste heat generation. Superheating is required after leaving the waste heat boiler and this is accomplished in an independently gas fired unit.

Figure 2. Diagrams showing typical waste heat boilers used in conjunction with oil heaters. (A) Convection type steam generator utilizes heat in flue gases which would be wasted to atmosphere. (B) Separate waste heat boiler is equipped with an induced draft fan to draw high temperature flue gases over the heating surfaces.



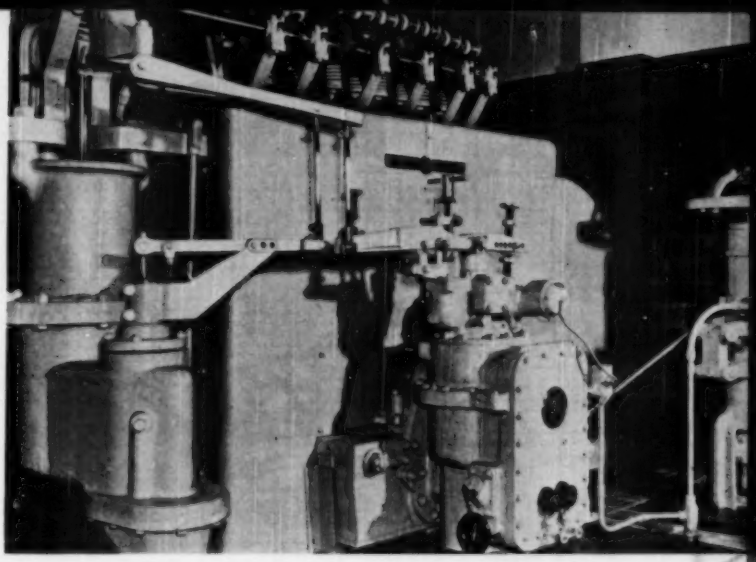
Gas Turbines

Refiners made the earliest commercial applications of gas turbines in the United States. Houdry fixed-bed catalytic units use gas turbines in all installations. By compressing 60,000 or more cubic feet per minute of air in gas turbine driven axial-flow compressors, considerable power savings are made. Use of these turbines permits reduction of power plant equipment and operating costs. Allowable inlet gas temperatures have steadily increased, 800 to 950° F. being common practice today. The horsepower ratings of these units vary from about 3000 to 6000 hp, with air discharge pressures of approximately 50 psi. More extensive applications are dependent upon development of better high temperature alloys. When these materials become available, refiners will be among the first to find new uses for gas turbines in various production operations and for driving auxiliary equipment.

Natural gas expansion turbines are finding more uses in oil and gas fields and refineries. Low first cost, high effi-

ciencies, and lack of fire hazards make these units ideal for the refining industry. Also, the gas exhausted from the turbine has undergone no chemical change and is still suitable for use in process operations or as boiler fuel. As a result natural gas expansion turbines are now often used in place of reciprocating engines or electric motor drives. Obtainable from several manufacturers, these units should receive careful thought when establishing a power-process balance because they will often supply much needed power without expensive alteration of existing steam power facilities.

Power is produced from natural gas turbines by expansion of any of the commoner gases through a unit similar to a standard single stage steam turbine. There are only a few slight differences between the usual single stage steam turbine and the natural gas expansion turbine. Except when using sour gases, special blade, rotor and casing materials are unnecessary. Even when using sour gas, a standard unit may prove satisfactory provided that usual operating conditions of the turbine are not exceeded. To prevent moisture condensation, low exhaust temperatures should be avoided in application of these turbines, the minimum allowable value being about 40° F. When exhaust temperatures fall below about 40° F., preheating of the gas prior to inlet is necessary. Natural gas fired superheaters, steam jacketed inlet lines, or heat exchangers can be used to produce the desired preheat. Leakage past shaft sealing glands, a potential fire hazard, should be provided for by use of a jet exhauster connected to the glands or use of grease-sealed glands.



—Courtesy of General Electric Company.

Figure 3. Close-up view of valves and governing mechanism on a modern turbine-generator set in a refinery power plant. Units such as these produce low cost power necessary for today's high refinery outputs.

General Design Notes

Ideally the refinery designer should have a broad specialized knowledge of both power plant design and process system design. Actually these qualities are seldom found in one man because the necessary educational background and design experience require almost a lifetime to obtain. As a result it is common to find two men, one a process designer and the other a power plant designer, in charge of larger refinery building programs. If these men possess a good general understanding of each other's problems, an efficient, easily operated, and well planned plant can be erected. Low cost production of quality products, the ultimate aim of all good design, is obtained only when refinery process operations are thoroughly analyzed in conjunction with various power plant schemes. By cut and try methods the best power-process balance can be secured and efficiency built into the refinery as a whole.

Basically a good power-process balance involves 1) prevention of waste of power plant generated steam, 2) use of low pressure steam where it is most effective, and 3) use of high temperature and high-pressure steam in boilers and main turbines.

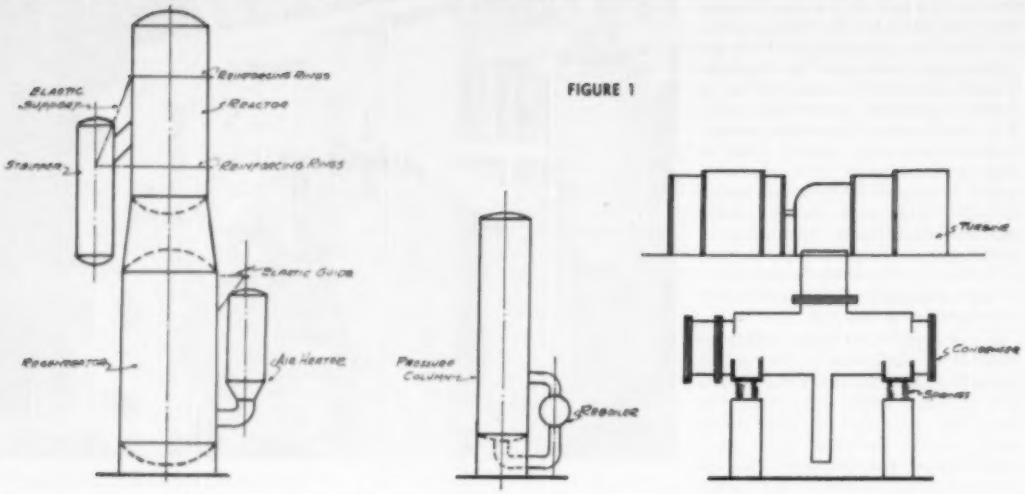
The simplest way to prevent waste of power plant generated steam is to use every pound of it for process. However, this is not always possible because process outputs vary from day to day and year to year, as do electrical requirements. The problem then becomes one of supplying steam as needed and at the same time supplying the required electrical power. To date, the best method of furnishing these two streams of energy without waste is by use of high-pressure turbine generators exhausting to process mains. When process loads exceed turbine exhaust quantities some form of pressure reduction which performs useful work between the high and low pressure mains is best for over-all plant economy.

Steam pressures and temperatures, high or low, always affect plant operating economy in some way. High steam pressures and temperatures for turbine generators are synonymous with economy. They may not, however, be economical for certain process operations where only moderately high temperatures are needed. It is usually better economy to expand the high pressure-high temperature steam through a few stages of an efficient turbine and then bleed the required amount at the approximate temperature needed. Likewise, low pressure steam for heating operations, obtained by simple pressure-temperature reduction from high pressure mains, is often wasteful of energy because it by-passes a power producing unit. A better arrangement utilizes most of the heat in the high pressure steam for some power plant service and then exhausts it at the required pressure to the refinery. For instance, high pressure-high temperature steam, needed for process work at low pressure, can be passed through a feedwater heater, reciprocating pump, or auxiliary turbine before entering the process main. In many cases use of a feedwater heater for the pressure-temperature reduction is better than a pump or auxiliary turbine because the heater operates constantly. Pumps and auxiliary turbines are often idle when low pressure process steam is needed.

There are those who rigidly adhere to the old notion that the refinery power plant is always of secondary importance because "fuel is cheap, free in fact, and not only that, we're producing petroleum, not electricity." True, the function of a refinery, natural gasoline plant, or petrochemical plant is the production of a certain commodity. But every kilowatt hour and pound of steam used in producing this commodity is reflected in the final cost per unit quantity. Since low cost production is the aim of all plants, the importance of an efficient power plant cannot be ignored, regardless of fuel costs. That is why American refiners are now using the most efficient power plants obtainable in conjunction with the best production methods available.

(End of Part III and series.)

FIGURE 1



EXPANSION JOINTS

And Their Application

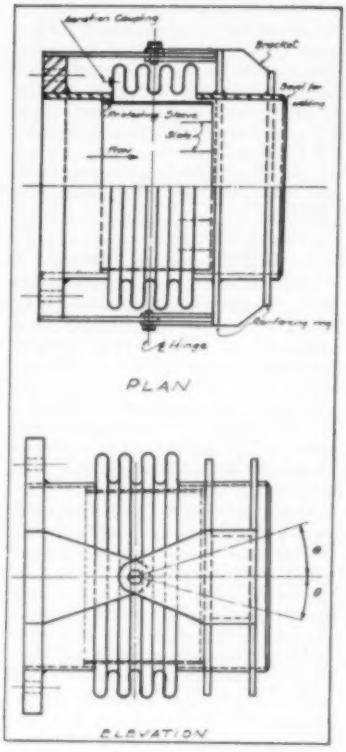
F. E. WOLOSEWICK,
Sargent and Lundy, Engineers, Chicago

IN ORDER to minimize or eliminate destructive forces from thermal expansion of piping, three procedures are followed. The first, that of "non-resistance," in which the major equipment is displaced bodily by specially designed rigid piping through the full amount of expansion. The second procedure assumes process equipment stationary and expansions are absorbed by flexure of interconnecting piping, or by expansion joints. The third, is a special case, involving combination of the above two.

There are certain disadvantages associated with the first method of absorbing expansions. Forces necessary to displace heavy process equipment may be too large for other equipment or structures to resist. Lubricated bronze plates or rollers are used to decrease these forces.

To prevent localized failures all possible weak points of connecting piping, equipment, and structures must be carefully analyzed, and properly rein-

FIGURE 2



***THERMAL EXPANSIONS** in refinery piping are most often accommodated by means of the inherent flexibility of the piping layout. Where sufficient room is available the necessary expansion can often be provided at low pipe-material stresses and without any serious complexities of process equipment layout. Often, however, there is just not enough room for the convenient use of piping layout and pipe bends as a means for providing expansion requirements. In such cases especially designed expansion joints of either packed or bellows type are often used to good advantage. The bellows type enjoys freedom from packing renewal and leakage problems. Earlier articles have treated the use pipe bend type expansion joints in process plant applications. This article deals with the use of the bellows type joints and should provide useful information for engineers concerned with plant piping systems.*

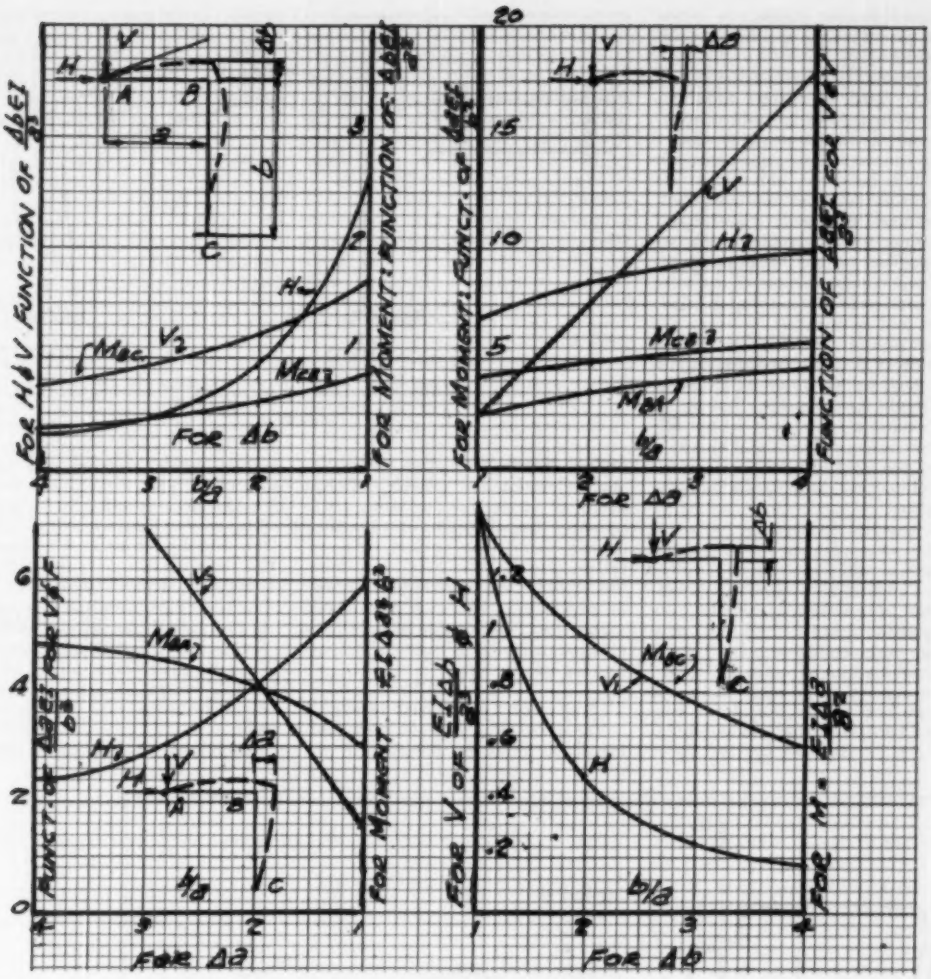

FOR H & V FUNCTION OF Δb EI/l³
FOR MOMENT: FUNCTION OF Δb EI/l²
FOR MOMENT: FUNCTION OF Δθ EI/l²
FOR H & V FUNCTION OF Δθ EI/l²
FUNCT. OF Δθ EI/l² FOR V & H
FOR MOMENT: FUNCTION OF Δθ EI/l²
FOR V OF EIΔb/l³ & H
FOR M: FUNCTION OF EIΔb/l²
For Δθ
For Δb
For Δθ
For Δb

FIGURE 3

forced. Some types of equipment when displaced may aggravate vibration conditions, the field correction of which may be difficult.

It is possible at times to connect various process equipment together and decrease expansions considerably. Illustrations are taken from actual oil refinery installations as follows: attaching stripping columns to reactors, direct fired air heaters to regenerators, reactors to regenerators, reboilers to pressure columns. In power plants, condensers are frequently attached to turbo generators. (See Figure 1.)

Considerable economies are possible through direct connection of process equipment. Structural towers, foundations, and interconnecting expansion joints are eliminated. Connecting piping is simplified since large tri-axial expansions due to elevation and location of equipment are practically eliminated.

Such arrangements of directly connecting and supporting one process equipment from another, requires careful and thorough stress analyses of all critical points. Careful proportioning of necessary reinforcing ribs attached to thin walled process equipment is absolutely essential. Due considerations must be given to creep stresses at elevated temperatures. Equally important is the necessity of properly insulating external reinforcing rings in order to keep stresses due to temperature difference as low as possible.

Stationary Equipment

In the second method of absorbing expansions, process equipment is stationary, and expansions between them are absorbed by flexure of interconnecting piping. If piping runs are straight, expansion joints are introduced into the line to absorb expansions.

Forces and moments in interconnected piping can be determined by moment areas, least work, or through the use of column analogy. As piping layouts become more complicated, mechanical model analysis offers easier solutions. Forces from expansion of piping must never exceed the safe carrying capacity of equipment. Otherwise excessive forces may cause serious troubles, and lead to failure.

When expansion joints are used, expansions are absorbed by thin corrugated bellows, or by sliding of one sleeve into another. In the sleeve-type

joint, considerable packing is necessary to prevent leaks around the sliding parts.

Corrugated type expansion joints are often used to correct misalignment due to installation and fabrication, control vibrations, and supply flexible connections to piping through water tight bulkheads and walls.

In process industries employing high temperatures, corrugated type expansion joints offer possible means of absorbing expansions. In general, expansion joints are selected on the basis of process considerations, space limitations, and economy.

When process considerations require minimum of pressure drop, piping and ducts must be as direct as possible. With high temperatures, flexure of large diameter piping may be too difficult or even impossible. Expansion joints when used correctly in conjunction with piping provide the required flexibility.

Economic considerations influence selection of expansion joints. Balancing costs of additional piping for flexibility, additional insulation, guides, supports, counterweights, against costs of expansion joints and anchors, may indicate considerable savings.

Frequently lack of space, as, for instance, aboard ship, necessitates use of expansion joints. Except for conditions outlined above, most expansions can be absorbed by bending of piping. Nozzle orientation, or equipment relocation may provide sufficient length of piping for flexibility. Utilization of branch piping in absorbing expansions of main headers offers excellent possibilities. Flexible properties of long and short radius ells can be used to good advantage. Corrugated piping has considerable possibilities, although it may be objectionable from process standpoint.

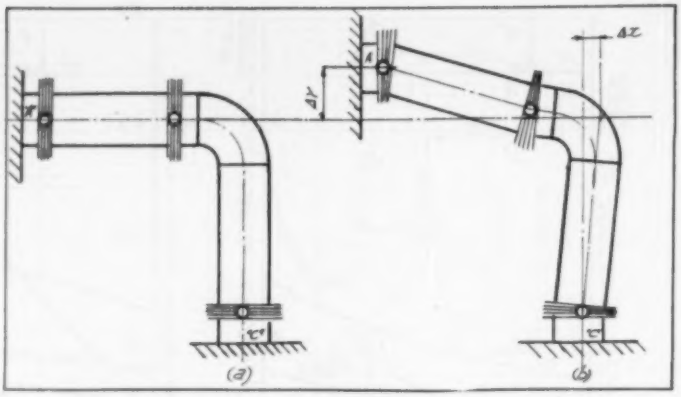


FIGURE 4

Types of Corrugated Joints

There are two types of corrugated expansion joints, the hinged type permitting angular rotation, and the displacement type, absorbing longitudinal expansions with a limited amount of transverse displacement.

A hinged joint is shown in Figure 2. The joint consists of a series of thin corrugated elements welded to short lengths of pipe, with brackets containing pins, which permit angularity, resist internal pressures and reactions. When the joint rotates, piping becomes flexible, reactions are smaller and may be resisted readily by process equipment.

Angularity of joint can be doubled

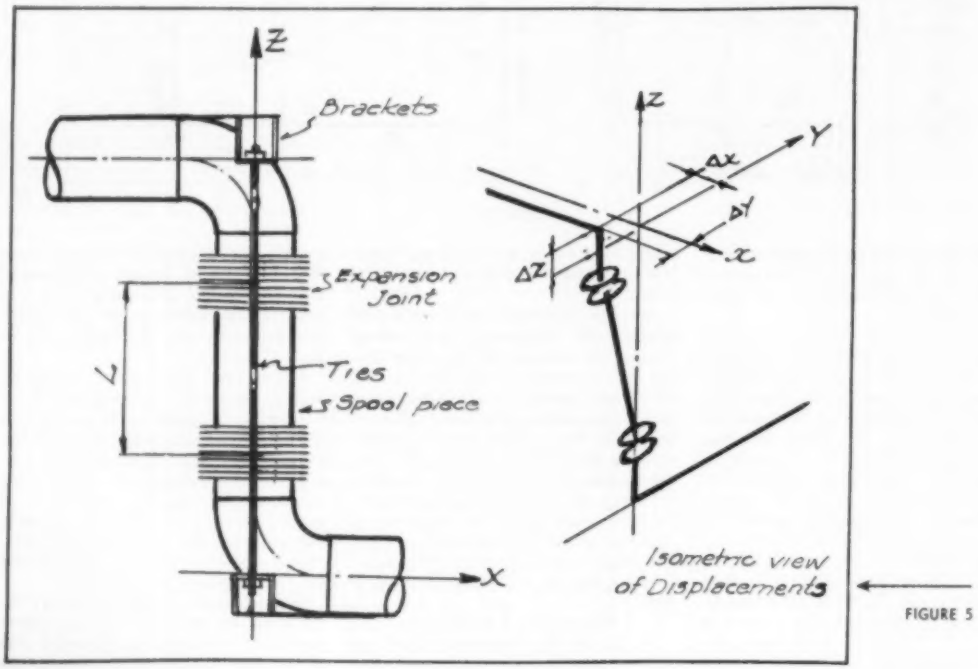


FIGURE 5

through proper pre-strain of piping. Piping when so installed has a considerable reserve for emergencies. In order to expedite analyses of simple type bends with hinged expansion joints, graphs in Figure 3 will be useful.

Hinged expansion joints should be located adjacent to process equipment. Such installations minimize bending moments on equipment, and reduce possibility of stress corrosion zones.

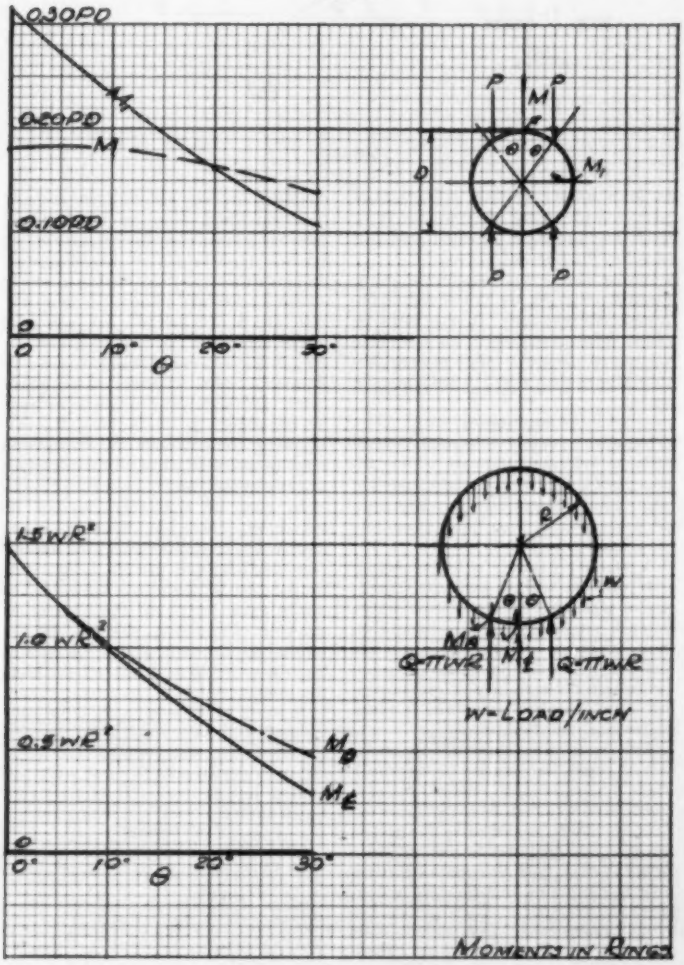
Extreme limit of structural stability would be a duct having three hinged expansion joints as shown in Figure 4. Such arrangements can handle large amounts of bi-axial expansion. A planer pipe bend with four expansion joints would be statically unstable.

Another possible arrangement of expansion joints is shown in Figure 5. Two displacement joints in series with a connecting spool piece, tied together, can absorb considerable amounts of tri-axial expansions. The amount of translation is a function of flexibility of the joints, and the length of the spool piece. With proper design, considerable translation and rotations are possible.

Brackets for the tie rods should be located on center lines of horizontal headers. Bracket design becomes a major problem at elevated temperatures. Bending moments in ells and pipe cannot be evaluated accurately. Approximate methods of analyses are indicated in Figure 6, with calculations based on an inch height of wall. Stresses so determined should be combined with internal pressure to determine resultant values.

At high temperatures external rings must be provided. It is convenient to utilize part of the wall of the pipe to act with stiffening ribs. Rings must be properly insulated to decrease stresses due to temperature differences.

FIGURE 6



Construction of Expansion Joints

Bellows-type expansion joints consist of a series of thin corrugated elements, capable of resisting internal pressures, able to absorb longitudinal expansions by flexure of bellows, and certain amount of transverse displacement by shearing action. When such joints are hinged, angular rotations are possible, through contra-flexual displacement of bellows.

Figure 7 shows some of the commonly used expansion joint elements. Items "c" and "d" are easily fabricated, while other shapes require special dies.

From practical design, item "d" may be viewed as a thin plate with restrained ends. From Theory of Elasticity, necessary equations for stress, deflection and forces can readily be determined. As deflections exceed thickness of bellows, membrane stresses become important. For a flat plate element as shown in Figure 7d, stiffness is increased 8 percent when deflection is 0.6 of the thickness, 30 percent when deflection is 0.7 of the thickness, 60 percent when deflection is equal to plate thickness, and 200 percent when deflection is 1.25 times the thickness.

To decrease effects of membrane stresses, expansion joint elements are formed into various shapes as shown in Figure 7. These shapes permit radial stretching, and increase flexibility of the joint considerably.

For more complicated contours, stress, deflection, and direct forces are difficult to evaluate mathematically. Any differential element of the plate behaves like a beam on an elastic foundation. Derivation of differential equations correlating displacements with forces is complicated by physical discontinuities. Apparently no mathematical treatment has been published discussing conditions in thin corrugated bellows.

A somewhat similar problem was studied by Dr. L. H. Donnell, while investigating flexibility of corrugated piping. In his analysis Dr. Donnell considered an elementary semi-circular segment under the action of two forces as indicated in Figure 7i. Change in radius "r" was expressed in terms of angles "dφ" and "Θ." Bending moments were expressed in terms of these angle changes, while variation of bending moment was expressed in terms of Fourier series with variable integers.

Equations developed by Dr. Donnell applied to thicknesses 10 to 15 times greater than those of expansion bel-

lows, with a large ratio of "R/r," and a small ratio of "r/t." Within these limits Dr. Donnell's equation would give rational values for design of expansion joints. However most expansion joint elements are considerably beyond the range of above values. Analysis of current expansion joint bellows against the above equations indicated values to be to three times higher than those given by the manufacturer.

Most stainless steel expansion joint bellows have a ratio of displacement to thickness anywhere from 2 to 5. Hence membrane stresses which are serious for flat plates are apparently relieved through secondary bending of circular segments, causing a more favorable stress distribution.

Under internal pressure, stress distribution is further complicated. To prevent joints from failure under large internal pressure, reinforcing rings, accurately finished, are fitted into the convace parts of corrugations. It is assumed that the upper part of that section of the bellows, outside of the reinforcing ring will act as a cylinder of diameter "2r." Hoop stresses can then be determined quite readily. With such construction considerable internal pressure can be resisted, since the external reinforcing rings will carry the major share of the load.

From standpoint of stress distribution corrugated bellows with smooth semicircular segments have distinctive advantage over other types, in that there is an absence of stress raisers. Such factors are important if vibrations are serious.

Blowout Pressures

Under internal pressure positive or negative, external forces must be applied to the ends of the pipe to prevent failure of joint. These forces are equal to the product of internal pressure, and a proportional part of the area of the joint, plus the force necessary to compress the bellows.

Frequently blowout pressures are calculated on an area defined by external diameter of the pipe. This assumption gives low values. If one were to visualize an element of the plate as a simple beam spanning between inner and outer radii, reactions to each support would be one half of the load. If the element adjacent to the pipe was fully fixed, $\frac{5}{8}$ of the total load would be contributed to the pipe. Studies of flat plates indicate approximately 70 percent of the bellows pressure to be carried by the pipe.

For purposes of anchor designs it is recommended that blowout pressures be computed over the gross area of the joint. This generally eliminates necessity of determining collapsing force on the joint, unless very low pressures are used, in which case force necessary to close the joint must be calculated and added to the internal pressure.

In the sleeve type expansion joint, blowout pressures are calculated on the largest internal area. To this must be added thrust necessary to overcome friction of packing, which is considerably higher than that for bellows-type joints.

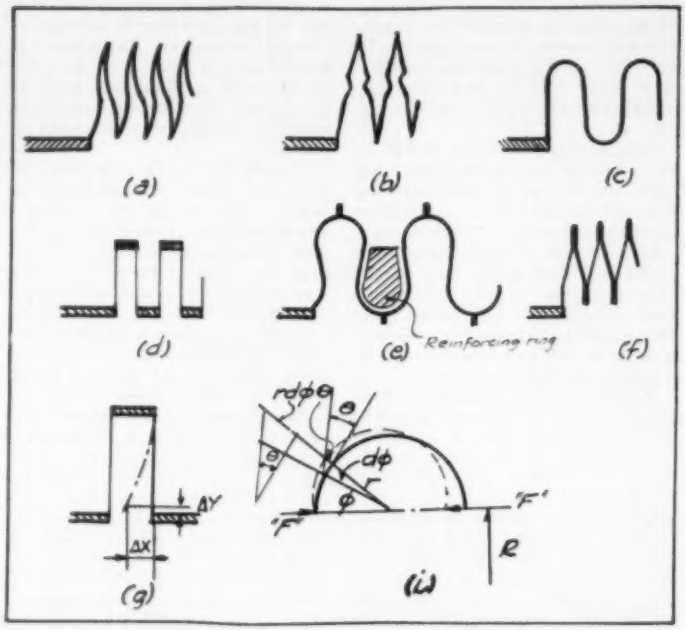


FIGURE 7

Conclusion

Expansion joints are used principally to relieve equipment of expansion forces. Incorrect use of expansion joints causes forces on equipment considerably greater than those from flexure of piping.

A common practice is to use expansion joints on turbine exhausts regardless of pipe size. In installation where exhausts are large size ducts, expansion joints offer one solution. For smaller turbines, expansion joints may aggravate conditions seriously. Flexible piping with complete pre-strain is more economical and fool-proof.

Although expansion joints are necessary at times, they should be used only when economic and process requirements are fully met. In many cases expansion can be absorbed by flexure, at times at a slight sacrifice of pressure drop. It may take considerable planning to determine suitable piping contour.

By construction, expansion joints are made up of thin elements. These elements are subject to high stresses from combined action of bending and internal pressure. Stress conditions are further aggravated by intentional or unintentional stress raisers. Overstressed zones are susceptible to corrosion attack. If bellows are not protected internally by a sleeve, erosion may be an important factor. Creep can become critical at elevated temperatures, although cooling medium may be introduced to the bellows, thereby lowering the temperature. Vibrations may reduce endurance limit, leading to fatigue failures.

In view of the large number of sources of weaknesses, expansion joints should not be expected to give trouble free performance over a long range period. It is therefore desirable to minimize as many of the stresses as possible. Expansion stresses can be minimized through proper pre-strain. Such practice should add to the life of the joint.

A study of expansion joint failures indicated absence of pre-strain. Although these joints were designed for the service at which they were installed, failure in most instances could be attributed to localized overstressing.

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REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others prominent in the industry.

Touch of Scotland Claimed by Engineer

Born in the land of plaids and kilts, Glasgow, Scotland, Robert Haldane, contributor of the API article, "Layout and Operation of New Shell Shop," which begins on page 79, came to the United States at the age of six. When he was 14, young Haldane left school to work in New England textile mills where for about five years he gained first-hand experience with maintenance of textile equipment as a mechanical helper. Later returning to school, Haldane received a B. S. degree in mechanical engineering from New York University.

At present Haldane is chief engineer of the Houston refinery of Shell Oil Company, which he joined in 1930 as a gauger in the Dubb's plants. He was also cracking-plant inspector and technical assistant in the cracking department. While with the engineering department he handled problems on lubrication engineering, estimating, and field construction work. During his service as utilities engineer, Haldane was in charge of operation and maintenance of boiler and power-house, cooling, and domestic water systems.

On military leave in 1942, he became an aircraft-maintenance officer assigned to the US air mission to Bolivia where he was in charge of establishing maintenance and supply procedures for the Bolivian air force. Afterwards he returned to Shell as assistant chief engineer in charge of maintenance and later was promoted to chief engineer.

Quartet Gives Data On Small Refinery

John S. Pfarr, William F. Dougherty, Leon T. Harris, and Robert W. Pollard —all from Leonard Refineries, Inc.'s Alma, Mich., refinery — comprise the quartet writing the API paper on "Maintenance Practices in a Small Refinery," page 105.

Wolosewick

Haldane

Pfarr, a Harvard chemistry graduate began in the oil business in 1930 with The Standard Oil Company (Ohio) as a pipe-fitter's helper at the Latonia, Ky., refinery. While there he became crude-still foreman, chief chemist, pipe-still foreman, shift foreman, manager of asphalt manufacture, and Class A process foreman. In the interim period between 1936 and 1943 he was associated with the company's No. 1 refinery at Cleveland, and Ashland Oil and Refining Company serving at various times as manager of asphalt manufacture, chief chemist, and technical director. Since with Leonard Refineries in 1943, Pfarr has been technical director, member of the board of directors and vice president in charge of manufacturing.

Pollard, general superintendent of refinery operations, has been with Leonard Refineries since 1936 when he began as crude-still operator. Other positions with the company have been as cracking-plant operator of the Dubbs cracking unit, and superintendent. Previously, Pollard was employed by Universal Oil Products Company in Arkansas City, Kan., Producers and Refiners at Parco, Wyo., and Allegheny Arrow Oil Company at Canton, Ohio.

Most of **Harris'** experience from 1914 to 1936 was with the automotive industry, including Maxwell, Hudson, Dodge, Delco Remy, and Chrysler companies. He became associated with Leonard Refineries in 1936 as master mechanic and in 1945 was made superintendent of maintenance.

Dougherty was graduated by the Pennsylvania State College in 1942, with a B.S. in petroleum engineering. During World War II he served as engineering officer, combat battalion, from 1942 until 1946. He then became associated with Leonard Refineries as chemical engineer and since that time has been working as combustion engineer, metal inspector, and as the head of the refinery-yield department.

Writer and Teacher Contributes Article

F. E. Wolosewick, author of "Expansion Joints and Their Application," page 146, was graduated from Armour Institute of Technology with a bachelor of science degree, then obtained his master's from Massachusetts Institute of Technology. He did postgraduate work in theory of elasticity and applied mechanics at Illinois Institute of Technology.

As consulting engineer he has worked on prestressed concrete, steel and concrete structures, expansions of piping systems, and special refinery problems associated with pressure vessels and other process equipment.

Wolosewick is author of "Flexure of Cellular Shells," Journal of American Concrete Institute, Dec., 1949, and "Methods of Making Piping Flexibility Analyses," Heating, Piping and Air Conditioning, Sept., 1948. A series of articles has been completed on "Stability of Pumps and Turbines and Pressure Relief Valves Under Expansion Forces; Simplified Analyses of Piping Systems, Designs of Long Range Transmission Piping, and Design Methods of Supporting Vertical Pressure Vessels."

Wolosewick taught courses in mechanics and expansions of piping systems in the evening division of Illinois Institute of Technology. From 1942 to 1948, he was an instructor in mechanics,

Pfarr

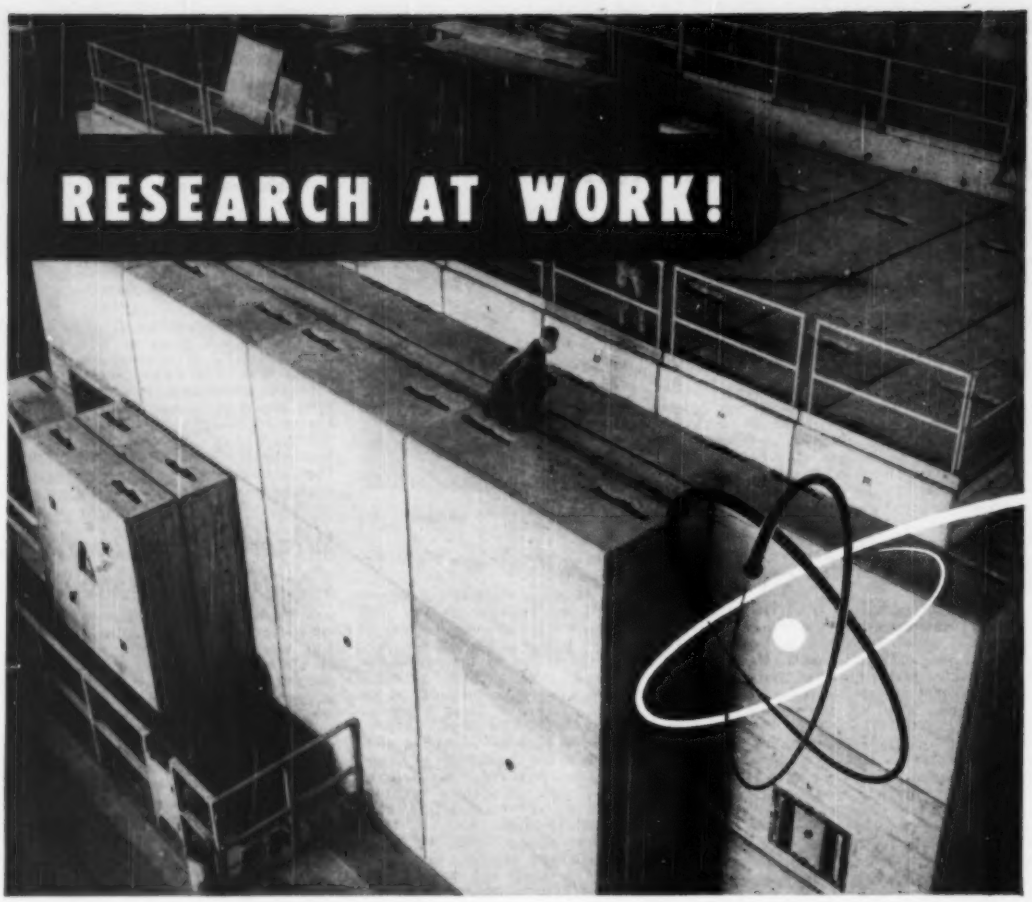
Pollard

Dougherty

Harris

McNeil

Draughon



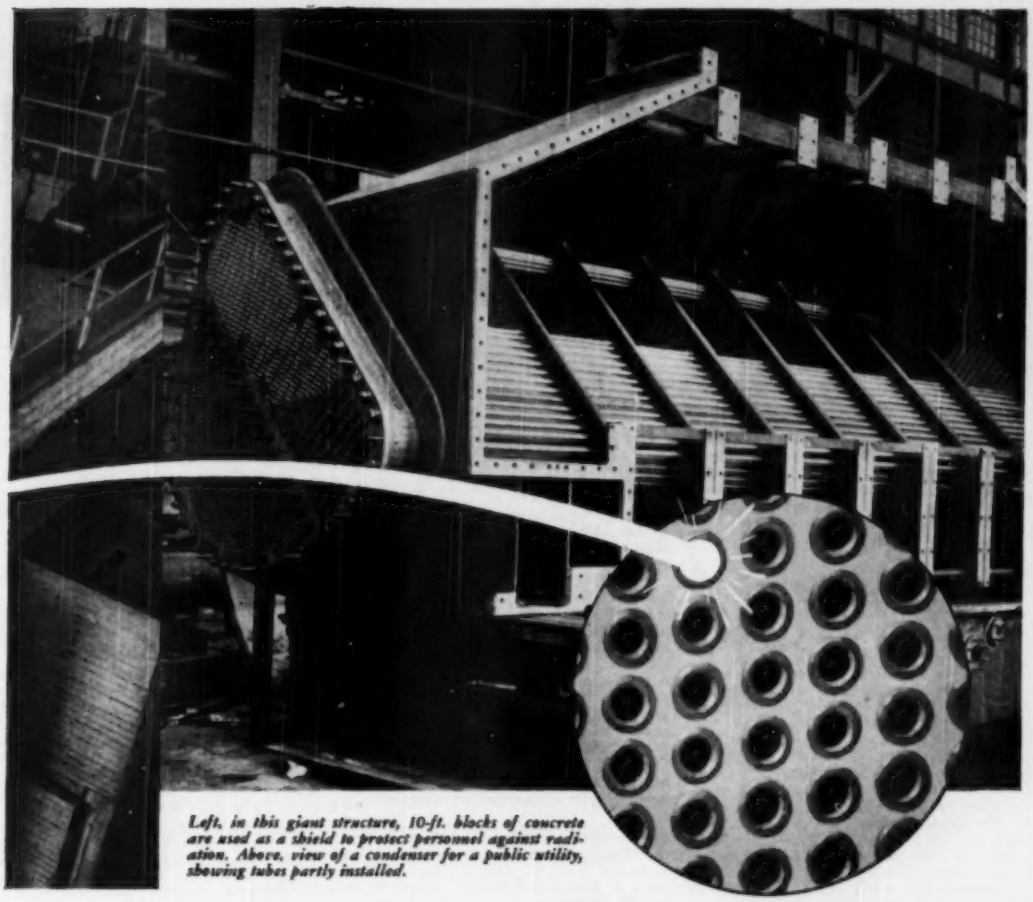
Long before Hiroshima, Revere used the atom—constructively

BEFORE the first atomic pile was built, before the first atomic bomb was exploded, Revere used the effects of the disintegrating atom for constructive research. It was in 1941 that radio-active tracer elements were employed in a Revere-sponsored investigation into the destructive process known as dezincification. This is a form of corrosion formerly of chief concern to users of copper-zinc alloy condenser tubes. In this process the alloy seems to be dissolved from localized areas, the zinc going off in solution while the copper is re-deposited as a porous plug.

A number of years ago it was found by experiment that the addition of small amounts of some other element would prevent or inhibit this electro-chemical action. Nobody knew just why or how, nor what was the best percentage for the third element. Revere decided to find out, and commissioned two able scientists in a famous Eastern technical school to conduct the necessary experiments.

In this work, radio-active elements or isotopes were produced in a cyclotron, and were used in order to determine the function of those elements in rendering the alloy more resistant to corrosion.

Briefly, the method was this: The desired radio-active element was dissolved in an acid, and the solution's radio-activity calibrated by means of a Geiger counter. A standard sample of the alloy was immersed in the solution, and from time to time the amount of the active element deposited upon it was measured with the counter. The nature of the deposited film was also checked by the electron diffraction method. This



Left, in this giant structure, 10-ft. blocks of concrete are used as a shield to protect personnel against radiation. Above, view of a condenser for a public utility, showing tubes partly installed.

was in effect an accelerated test for dezincification and its inhibition. It was repeated many times with solutions of various concentrations. This, mind you, was in 1941, before radio-active tracer procedures were of any interest except to a comparatively few scientists.

The conclusions reached as a result of these tests can be summarized as follows: The corrosion of uninhibited copper-zinc condenser tubes occurs by solution of the alloy as an entity. When an inhibitor is present, however, in the percentages revealed by the experiments, the inhibitor is re-deposited on the alloy as a film which has about the same effective electrical potential as copper. The deposition of copper is thereby prevented. One of the key processes in dezincification having been thus interrupted, the process itself is effectively stopped, or at least so reduced in activity as to provide corrosion resistance, and commercial service, for extremely long periods of time. Thus the inhibited copper-zinc alloy condenser tube has become reliable and economical to an extent heretofore unrealizable.

Realistic Revere Research

Often the word "research" is thought to mean startling new discoveries and swift, amazing inventions. The fact is, however, that research does not work that way. Such modern devices as the automobile, the airplane, the telephone, radio, television, and numerous others would indeed be startling if they had been developed overnight. As we all know, they have reached their present high degree of development as a result of continuous improvement, detail after detail, problem after problem being worked out through countless hours and even years of the most painstaking research.

Revere's research is of that type. It is a continuing search for better knowledge of its materials and processes, and the way its metals may be utilized with the greatest efficiency and the maximum economy. This is not spectacular, but over the years it has made many contributions to the farm, the home, and industry.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

Ball | Smith | Dinneen | Gay | Duckworth | Jeffrey

mathematics, strength of materials, reinforced concrete and structures at Chicago Technical College. He was associated with Universal Oil Products Company in the design of piping systems and on special structural and mechanical problems associated with catalytic, hydrogenating, and other oil refinery units, involving high temperatures and pressures.

Engineers Present Word from the South

LSU is claimed as the same alma mater by southerners Charles R. Draughon, Jr., and Edwin B. McNeil, contributors of "Design of Cathodic Protection for Open-Box Type Coolers," page 97. Electrical engineering graduates of Louisiana State University, both Draughon and McNeil have spent most of their careers in the Pelican State.

Draughon, before joining the Louisiana Division, Esso Standard Oil Company, in 1939, was seismograph operator with Petty Geophysical Engineering Company. Since with Esso he has been meter and instrument mechanic, metal inspection engineer, and group supervisor in the equipment inspection department. He is now head of equipment inspection.

Draughon's activities include chairmanship of the arrangements committee for the meeting of ASME petroleum division. He is also a member of the executive committee of ASME New Orleans section. Other interests include membership in the technical papers committee of the Louisiana Engineering Society, NACE and Baton Rouge Industrial Forum.

McNeil has been affiliated with Esso as a metal inspection engineer in the equipment inspection department, and as corrosion engineer. For a year and a half he has been assigned to studies on cathodic-protection.

Mines Trio Reports

A U. S. Bureau of Mines trio, Dinneen, Smith and Ball, beginning on page 129 present "Determination of Olefins in Shale Oil Naphtha."

G. U. Dinneen received his bachelor of science degree in chemical engineering from the University of Denver in 1934. He worked for a time in a private laboratory in Denver, Colo., and for government laboratories in New Mexico and California. He has been engaged in shale oil research since joining the Bureau of Mines in 1945.

J. R. Smith attended the University of Wyoming to obtain a bachelor of science in chemistry and a master's degree in 1940 and 1942, respectively. Previous to joining the Bureau of Mines in 1945 in shale oil research, Smith worked for a private laboratory in New York. He is a member of American Chemical Society, Sigma Xi, and Phi Kappa Phi.

John S. Ball is a native of Hamlin, Texas, 1914. At Texas Technological College he received his bachelor of science degree in chemical engineering in 1934. He has an M.S. in organic chemistry, 1936. For advanced work he attended the University of Colorado from 1936 to 1938, after which he joined the Bureau of Mines at Laramie as a junior chemical engineer.

At present, Ball is refinery engineer in charge of the shale oil analysis and petroleum chemistry and refining sections at the petroleum and oil shale experiment station at Laramie. His work has been concerned with the sulfur compounds of petroleum, analytical methods for use in the petroleum industry, and studies on the composition and analysis of shale oil.

He is associate director of the API Research Project 48 A on "The Production, Isolation and Purification of Sulfur Compounds, and Measurement of Their Properties." Ball is a member of Tau Beta Pi, Sigma Xi, ACS and ASTM.

Trio of Researchers On Effects of Sulfur

A second trio contributing to this issue are newcomers R. E. Jeffrey, Jr., Errol J. Gay, and J. B. Duckworth whose API article "Effects of Sulfur in Motor Gasoline on Engine Operation" appears on page 111.

Jeffrey, who is automotive group leader in Shell Oil Company's products application department, San Francisco, joined Shell as research engineer in the motor laboratory at Martinez, Calif., in 1937—his activities concerned primarily with automotive fuels and lubricants, particularly in the integration of research activity with application experience. From 1940 to 1946, Jeffrey worked as ordnance reserve officer with the Office of the Chief of Ordnance in connection with the initiation of the ordnance fuels and lubricants program. He organized and directed fuels and lubricants research and development and was later promoted to lieutenant-colonel. He is a holder of the Legion of Merit.

For this article, Gay served as the coordinator of the field service tests on sulfur in motor gasoline. His current activities include being a consulting engineer, Detroit, technical consultant of Thompson Products, Inc., Cleveland, Ohio, and American technical advisor to the Associated Ethyl Company, Ltd., London. For more than 15 years he was associated with Ethyl Corporation here in the states. An award of "Exceptional Civilian Service" was given to him during the war years when he served as consultant to the War Department.

Duckworth became associated with Standard Oil Company (Indiana) at Whiting, in the research department in 1936, after graduation from Purdue University with a B. S. in mechanical engineering. Entering military service in 1942, he was assigned to the fuels and lubricants branch of the Air Force's Materiel Command at Wright Field and for his military service was awarded the Legion of Merit. In 1946 he returned to Indiana's research department as section leader and now is assistant director of research in charge of mechanical research. He is active in technical committees of the Coordinating Research Council, Society of Automotive Engineers, and American Society for Testing Materials.

Planners for Phillips

Phillips Petroleum Company early in May established a Research Planning Board as part of the Research and Development department to facilitate long-term planning of the company's research and development program and to improve its coordination with all company activities. The new board will comprise R. C. Alden, chairman, T. B. Hudson, W. A. Schulze and K. H. Hachmuth. The board will report to G. G. Oberfell, vice president of the department, through R. W. Thomas, manager. The board will be available for consultation to all departments of the company.

Several other changes of assignments in the Research and Development department were made at the same time. P. M. Arnold will assume the new position as assistant to the manager. R. L. Doan will replace Alden as director of the research division with T. W. Legatski and J. A. Reid as assistant directors.

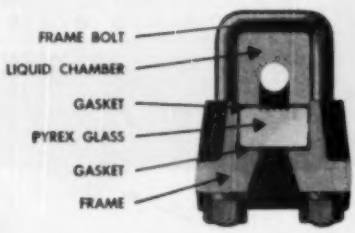
There can be NO MISTAKE in reading LIQUID LEVEL...

when you use

PENBERTHY Reflex GAGES

The refraction of light (an unvarying law of nature) makes the reading of Penberthy Reflex Gages unmistakable. Due to this refraction principle, the empty space always shows white—the space occupied by liquid always shows black. The dividing line between liquid and empty space is sharp and unmistakable, there can be no error in reading. It is easily read as far as you can distinguish between black and white.

Penberthy Drop Forged Steel Reflex Gages are available in whatever lengths required and for various liquids. They are also fabricated to customer's specifications from special alloys to meet unusual corrosive and temperature conditions. There is a Penberthy Gage of superior quality for every liquid level gage requirement.



3386

PENBERTHY PRODUCTS

PENBERTHY INJECTOR COMPANY

DETROIT 2, MICHIGAN

Established 1886 • **Canadian Plant, Windsor, Ontario**

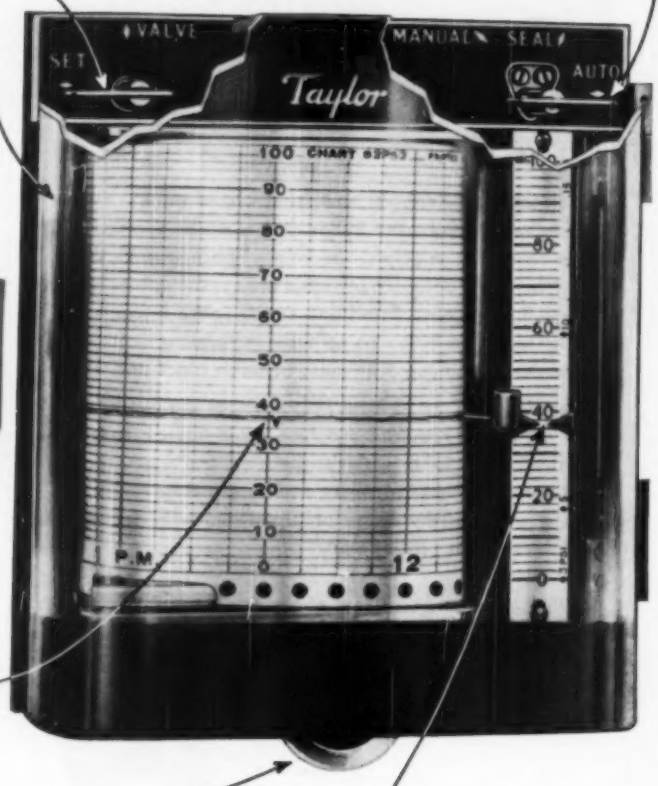
Announcing
TAYLOR'S TRANSET*

*Trade-Mark

MOVING THIS LEVER FROM NORMAL "SET" POSITION TO "VALVE" CAUSES SET-POINTER (extreme right center) TO INDICATE CONTROL VALVE OPENING.

AUTOMATIC-TO-MANUAL UNIT

STREAMLINED CLEAR PLASTIC DOOR ENCLOSES ALL ADJUSTMENTS, YET GIVES FULL VISIBILITY OF CHART, SET-POINTER, AND WHETHER ON AUTOMATIC OR MANUAL CONTROL.



ACTUAL SIZE 4 3/8" x 5"

THREE HOURS OF CONTINUOUS RECORD, FULLY VISIBLE ON RECTILINEAR CHART

SET-POINT ADJUSTMENT

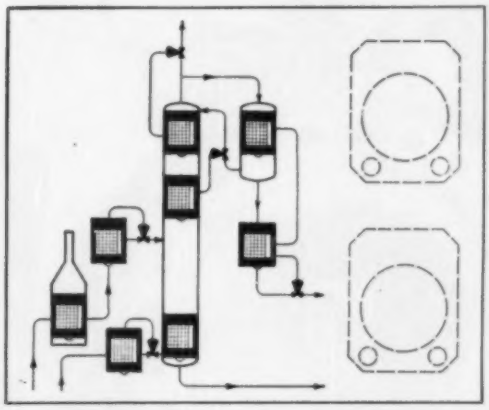
PROCESS CONTROL POINTER (left) DIRECTLY CONNECTED TO PEN, GIVES INSTANT COMPARISON WITH SET-POINTER (right).

TRY IT FOR SIZE! *Hold it right up on your panel board.*

RECORDER

A compact recording receiver for Pneumatic Transmission, which features:

- **4⅜" x 5" Strip Chart Receiver Greatly Reduces Panel Size**
- **A "Natural" for Graphic Panels; for conventional panels, too**
- **Gives Continuous 30-day Process Record**
- **Provides Instant Check on Controller Performance and Control Valve Position**
- **For Flow, Liquid Level, Pressure and Temperature**



Graphic Panels realistically relate instrumentation to the process. This scale drawing shows how Transet Recorders remotely record all the essential process data and take no more space than the most compact indicating receivers—**eliminating the need for space-stealing wings.**

1. AUTOMATIC-MANUAL UNIT
2. REMOTE SET-POINT ADJUSTMENT
3. VALVE POSITION INDICATION

WHY YOU NEED IT: The rapid, wide-spread demand for process information at a central point, requiring pneumatic transmission with conventional sized receivers, resulted in control rooms that became too large and too confusing. The problems thus created pointed the way to Graphic Panels and *now* to Taylor's new TRANSET Recorder. The TRANSET Recorder not only provides the needed processing data by means of a compact panel-space-saving recording receiver, but also provides remote setting of the control point, automatic-to-manual unit and valve-position indication—*right where you want it.*

UNIQUE ADVANTAGES: (1) Chart-drive mechanism easily removable for chart reloading (Complete assembly pulls out like a camera). (2) Scale (right side of illustration) shows actual process range of transmitter; also graduated 3-15 psi. for noting valve position and checking calibration. (3) Automatic-to-manual feature for convenience in start-up and servicing controllers. (4) Linear charts (time lines vertical) available in 100-line evenly graduated, or 0-10 square root. (5) Set-point adjustment, using a pilot-operated reducing valve.

WHAT IT DOES: The TRANSET Recorder records the transmitter output in terms of the process variable measured. The 3"-wide chart travels right to left, 1 inch per hour. It gives a continuous 30-day process record, with three hours of record visible. Charts may be torn off from left side as needed. Arrangement of combination pen-pointer gives full view of record as well as quick comparison with set-pointer. (See illustration at left for details on added features).

MODELS AVAILABLE: Four forms (all receivers 3-15 psi.): (1) One process record, set-point indication, set-point adjustment, valve position indication, and automatic-to-manual unit. (2) One process record, valve position indication, and remote manual valve loading. (3) One process record only. (4) TRANSET Indicator also available; operation of unit is identical to Recorder except that process variable is indicated instead of recorded. **Send for detailed information.**

Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.*

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

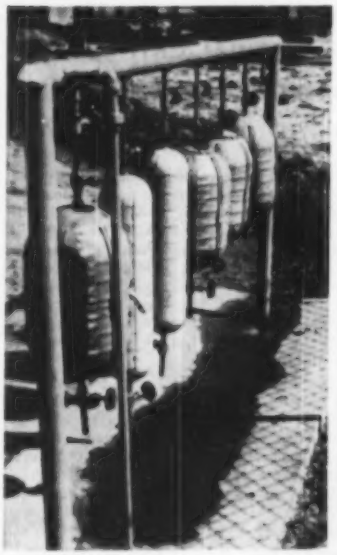
Maintenance and Operation

HOW TO DO IT

HOW TO—

Speed Steaming Of Sample Drums

The large stock of used and surplus stainless steel reinforced oxygen containers available has prompted one gaso-



line producer to adapt several of these light weight bottles as sample drums. The drums are used to ship vapors or liquids to testing laboratories. To clean returned drums to remove all traces of previous products, the operator built a rack to hold seven bottles for steaming. The operation requires no attention after the bottles have been connected to the steam manifold. The rack is built with two-inch pipe as end supports with a similar piece of pipe horizontally welded in place. A concrete drainage apron poured with a depressed center carries away all condensate and refuse drainings. The top rail serves as a steam distribution header and as a support for the bottles at the same time. Collars welded on the under side of the distribution header at convenient intervals are used as connections to which the pipe, control valves and other fittings are attached for steaming the bottles in a vertical position.

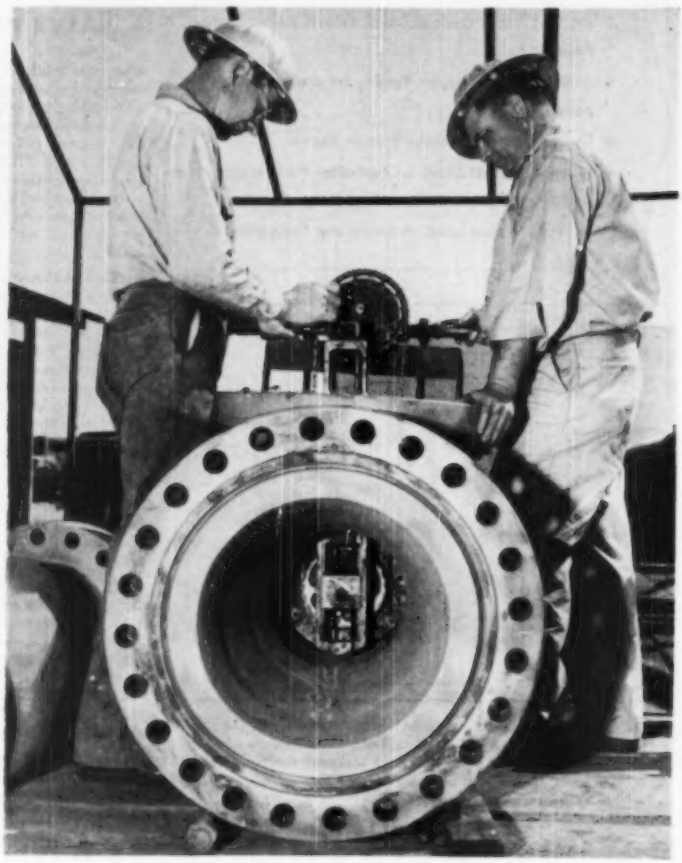
HOW TO—Resurface Valve Seat Rings for Hydroformer

The accompanying photograph shows two Humble Oil & Refining Company Baytown refinery employes, F. M. Bachmeyer, left, and D. F. Deckard, of the reclamation department, who developed the machine for resurfacing hydroformer valve seat rings. Formerly, the valves, which are subjected to wear and corrosion in service, were resurfaced tediously by hand. The two men received a cash award under Humble's "Coin-Your-Ideas" plan for the machine.

Two machines are used on hydroformer turnarounds at an estimated annual savings of approximately $4500.

The abrasive disc portion of the machine is driven by an air motor through two sprockets and chain. Its speed is controllable. Two men easily and quickly set up and adjust the machine, placing the abrasive disc in the valve port opening. By manipulating the screw level on top of the machine, the grinding disc is accurately centered, regardless of the diameter of the valve. Another level controls the pressure of the grinding operation as desired.

Photograph and story by courtesy of the *Humble Bee*, February, 1950.



WHAT are the basic principles and essential features of design of a modern Cold Process Water Softener or Clarifier?

WHY is the GRAVER REACTIVATOR superior to other designs of Cold Process units?

HOW does the GRAVER REACTIVATOR operate?

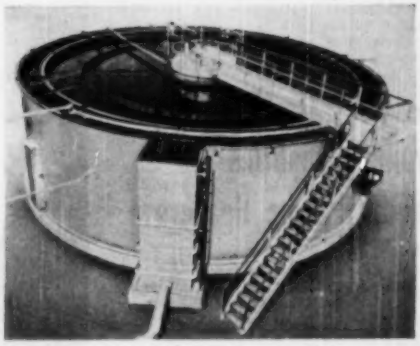
WHEN should the GRAVER REACTIVATOR be used for cold process softening or clarification?

WHERE are GRAVER REACTIVATOR installations in operation and what are the results obtained?

You will find the answers to these questions in a NEW bulletin on the GRAVER REACTIVATOR . . . a high flow rate, upflow solids-contact design of water softener and clarifier.

If your water supply is hard or contains silt, clay, color, organic impurities or other suspended solids, you will find this bulletin informative and helpful. Copies will be sent to plant executives and engineers who write on their Company letterhead.

GW-434



GRAVER

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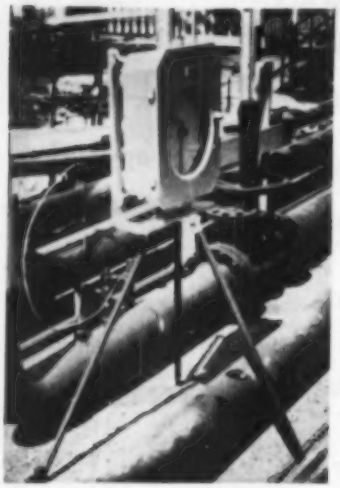
A DIVISION OF GRAVER TANK & MFG. CO. INC. EAST CHICAGO, IND.

HOW TO—

Make Tripod Support For Portable Instrument

Spot checks of temperatures at points not normally supplied with permanent instruments can be made over any period of time with an adjustable recorder mounted on a tripod. The legs of the tripod have sharp tips that can be pressed into almost any surface and will remain steady in the desired position. The fittings which connect the legs at

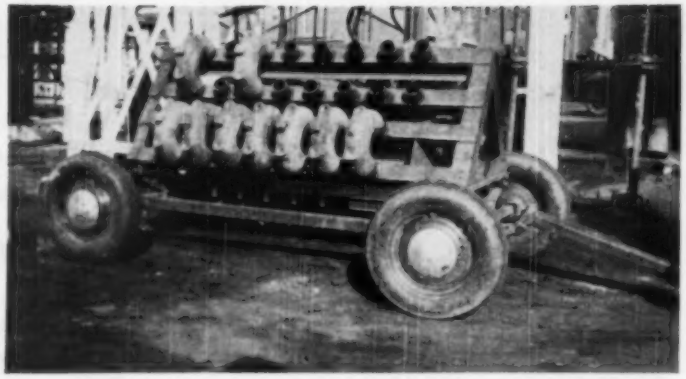


the top are hinged so that the legs may be spread to compensate for a surface which is not level. The platform to which the legs are attached resembles the "pan" head of a camera tripod and is made from a wide strip of steel plate to reduce vibration. The brackets to which the temperature recorder is connected are made of pipe and are welded to the tripod platform. The recorder weather-proof case is fastened to the brackets, top and bottom, with cap-screws.

HOW—

Trailer Simplifies Handling Tube Headers

Handling and shipping tube headers is accomplished quickly and easily at a large refinery without damaging the ends by use of a four-wheeled trailer equipped with a specially built frame. The trailer is a conventional automobile chassis. The frame is made as shown in the photograph with end pieces of angle iron with flat strap iron strips welded to the ends. The frame has an inverted V-shape. Four strips of the strap iron on either side serves as mounts for the support of the tube headers, which are pipe nipples welded to each strap and spaced so the tube



headers will slip over the nipples. This trailer is built to transfer 30 tube headers, 15 on each side, from the furnace to the shop for maintenance work.

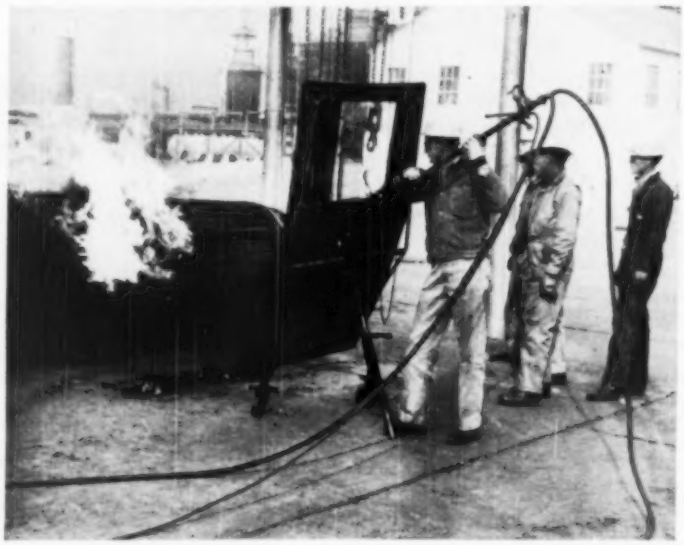
HOW TO—

Protect Operator When Cleaning Tube Bundles

The accompanying picture shows the operation of the burning process used in cleaning fouled heating elements. This process is the most practical method for cleaning bundles as mechanical or chemical solvent action methods are not too effective in reaching and removing the polymer from the nearly inaccessible spaces between the tubes near the center portion of the bundles. The burning of the polymer from the shell side of the tubes is somewhat erratic and small eruptions, flash backs, as well as blow-outs occur from the entrained material sealed in leaky tubes that have been temporarily repaired by plugging or blanking them off in the tube sheet. The operation of the process is therefore somewhat hazardous unless special protective equipment is used.

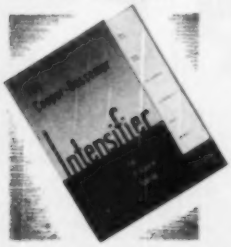
The safety shield or barrier shown was designed and constructed in the Plains Plant shops to permit the burning operation to be accomplished in a safe manner. Safety goggles, hard hats, safety shoes, and other standard protective equipment along with special equipment coupled with an active educational and training program has permitted Plains Plant to attain a record in January, 1950, of 3 million man hours worked without sustaining a disabling or lost-time injury. The record attained has earned the National Safety Council's Distinguished Service to Safety award.

The Plains Plant, government-owned plant for the production of butadiene, is operated by Phillips Chemical Company, wholly-owned subsidiary of Phillips Petroleum Company. (Photograph and caption, courtesy of PHILNEWS, March 1950.)



For all high pressure testing

SEND FOR THIS BULLETIN!



THE Cooper-Bessemer intensifier offers new advantages, new economies, wherever pressure testing is desired . . . for boilers, piping, compressor cylinders, pumps, *all* kinds of pressure vessels and laboratory destruction tests.

Completely air driven, the new intensifier eliminates fire and explosion hazards of motor-driven equipment, and easily develops hydrostatic pressures up to 23,000 psi using air at 90 lbs.

The extreme compactness and portability of the unit is another obvious advantage. It weighs less than 80 pounds, rolls easily to any job or location. Its completeness, versatility and low purchase price will also appeal to you . . . will save you still more dollars!

For complete information send to any Cooper-Bessemer office for a new bulletin covering use, maintenance, cost and delivery.

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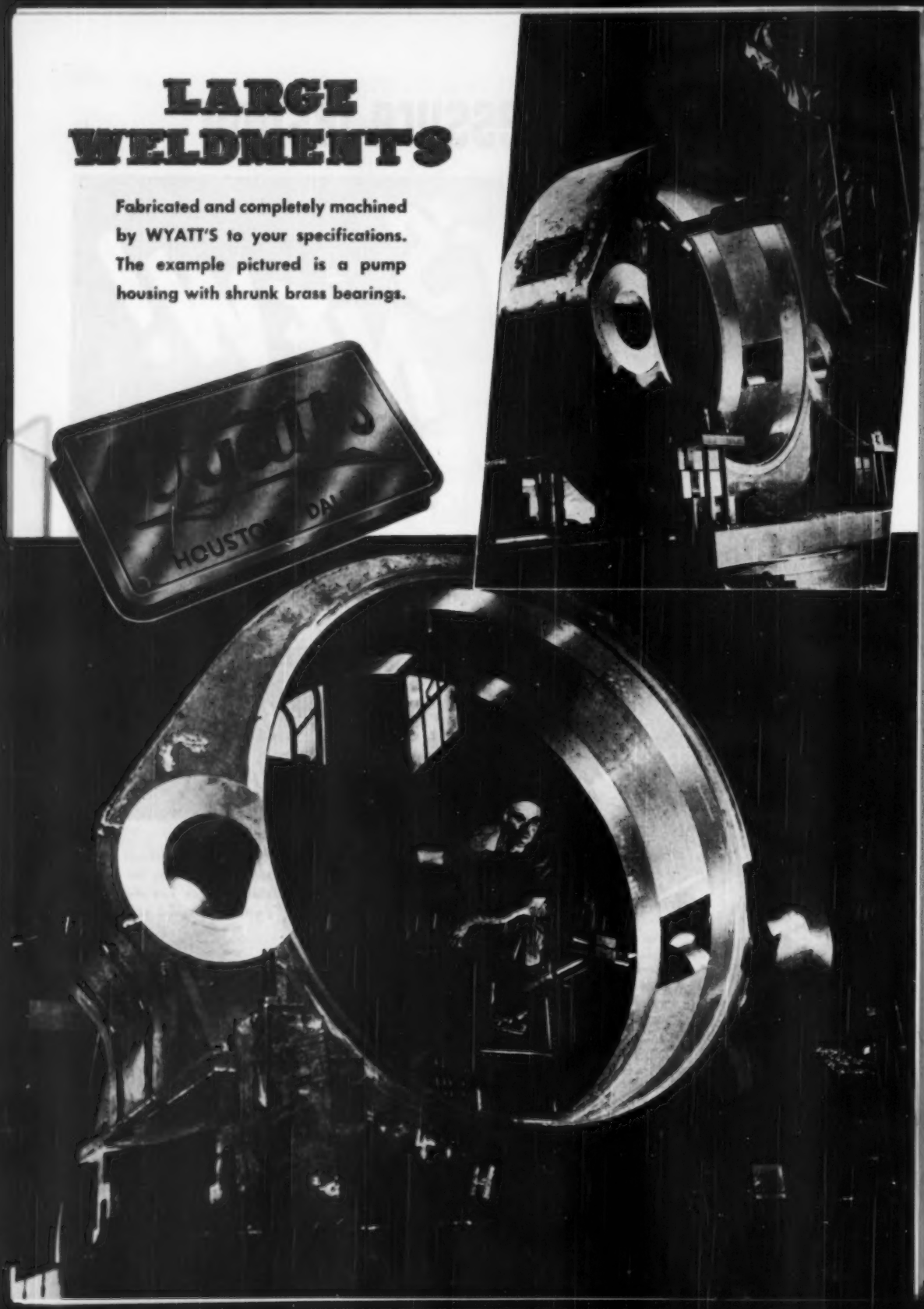
LARGE WELDMENTS

Fabricated and completely machined by WYATT'S to your specifications. The example pictured is a pump housing with shrunk brass bearings.



The MONTH... in the INDUSTRY

START OF REFINERY—Premier D. L. Campbell of Manitoba, photo above, at the controls of a diesel-powered bulldozer, recently turned the first sod for the new Winnipeg refinery of Imperial Oil Limited. The new $10 million plant, which will have a capacity of 10,000 barrels per day, is scheduled for completion in May, 1951. The projected cat cracker is said to be the first in western Canada.

Heading the new plant as superintendent will be Keith Lewis, formerly superintendent of the Montreal East refinery of Imperial Oil Limited. Lewis joined Imperial in 1933 at the Halifax, Nova Scotia, refinery. He has also been associated with St. Clair Processing Corporation of which he was assistant manager until the company's merger with Polymer Corporation.

Researchers Receive API Appreciation Awards

For their outstanding work in the field of petroleum refining, Doctors Robert E.

Hart Wilson

Wilson, chairman of the board of Standard Oil Company (Indiana), and W. B. Hart of The Atlantic Refining Company, received certificates of appreciation by the Division of Refining at the API's mid-year meeting early this month in Cleveland, Ohio. Selection for the honor was made by the division's general committee.

After World War I, Dr. Wilson joined Indiana Standard as assistant director of research at the Whiting refinery where he since has headed the development and patent department, was a director and a vice president. Dr. Wilson, holder of more than 90 patents and author of some 80 technical papers, has received honorary degrees from five institutions and has been awarded the Chemical Industry Medal and the Perkin Medal.

Dr. Hart, who lists his hobbies as biology, holds a doctor of pharmacology degree and a chemical engineering degree from the University of Pennsylvania. He is a well known advisor to municipal and state governments on antipollution and refinery wastes. Before joining the chemical engineering lab of Atlantic in 1923, Hart served eight years with E. I. du Pont de Nemours and Company. At present he is in charge of the gas, acids and drainage departments of Atlantic's Point Breeze refinery.

Pan Am Process Produces Benzene on Marketing Scale

Pan American Refining Corporation has announced what is believed to be the successful commercial production of synthetic benzene from petroleum. The first trial run on plant equipment at the Texas City refinery took place a year ago, and full commercial production started last December, according to L. W. Moore, president. Benzene so produced is not obtained by recovery from normal refinery streams. Briefly, the benzene is recovered through the dehydration of cyclohexane and the isomerization and chydrogenation of methyl cyclopentane.

Existing facilities at the Texas City plant have an estimated capacity of between three and five million gallons of 1° benzene a year. The new process promises to open up a previously untapped source of benzene which at the present time is in very short supply, according to Moore.

Refining Minimum Wage Survey Getting Under Way

The wage and hour and public contracts division of the Labor Department is laying the groundwork for launching a wage survey of the oil refining industry as the first step in establishing minimum wage requirements for those refiners bidding on government contracts in excess of $10,000. The survey would take about three months and results would be discussed at a public hearing.

Included in the survey would be the refining of motor gasoline or jet engine fuel in a natural gasoline or recycling plant, or the manufacture of finished lubricating oils in a reclaiming or compounding and blending plant.

Texans Propose Measures To Halt LPG Surplus

Proration of all hydrocarbons on an equal basis was urged by Independent Refiners Association of America at a hearing last month of the Texas Railroad Commission called in an attempt to halt flaring of butane and propane. Data presented by the association showed 28 Texas refineries shut down and the remainder operating at an average of 76 percent of capacity while 37 cycling plants have operating average of 112 percent of capacity.

Increased use of butane gas as a motor fuel was suggested by Ed Selecman, Shamrock Oil and Gas Company, as one way to solve Texas' mounting surplus of liquefied petroleum gas. Legal restrictions handicap use of butane as motor fuel, he said. In Texas, each trucker must get a special permit, file monthly reports, and pay taxes. "If this fuel could be marketed through filling stations like gasoline, it would cure the situation" Selecman said. This is done in some areas including the large truck service stations on the West Coast.

Eastern States Engineer Is Named Vice President

Reginald N. Blaize has been elected by the board of directors as executive vice president of Eastern States Petroleum Company, Inc., Houston. Blaize began as inspection and process engineer in 1940 and since has served as assistant plant superintendent and chief engineer. He has been manager of refineries since 1948.

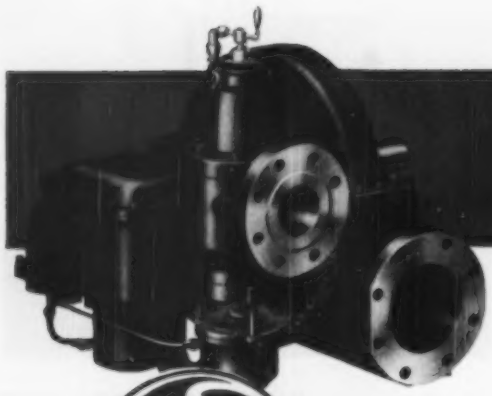
Blaize

Blaize studied at Tulane University and Louisiana State University where he majored in chemical engineering and received his B.S. degree. His initial experience in petroleum processing and engineering was with Lion Oil Refining Company.

API Safety Department Becomes Technical Services

Elmer O. Mattocks is leaving Phillips Petroleum Company, and Frank Wilson is being transferred by API from Washington, both to take up key posts in the conversion and expansion of API's department of safety into a new department of technical services. D. V. Stroop, who has been safety department c[illegible] will continue as assistant to the [illegible] dent of API.

Mattocks, engineer speciali[illegible] on



SAVE

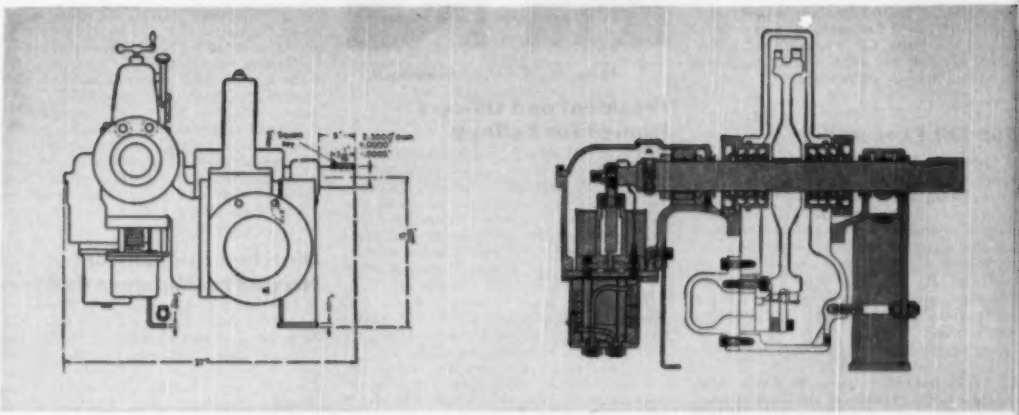
TYPE **DP**

General Electric's DP turbines, available in three frame sizes and a variety of ratings, can be profitably used in many different applications, yet they compose a standard line and incorporate standard parts. This standardization gives you four important benefits:

1 EASY TO STOCK SPARES Because most parts are interchangeable on all models, spares can be stocked at low cost. A spare parts kit, containing 91 items, can be obtained with the turbine. This simple method of stocking spares lowers maintenance costs and provides protection for several DP's in your plant.

FOUR WAYS

WITH Standard Turbines



2 INSTALLATION SIMPLIFIED

All models, regardless of frame size, horsepower, or speed ratings, have identical shaft height, keyways, and coupling fits. Thus, installation problems are simplified, and you can move these center-line supported units from job to job without a "custom line-up."

3 GREATER FLEXIBILITY

As the shaded parts in the diagram illustrate, most DP parts are identical on all frame sizes and ratings. In this way, you can adapt a DP for different job requirements with only minor changes. A different nozzle plate gives you a different horsepower output. A change in governor gears provides a new speed range. When modernization programs demand a change in plant operation, the DP's flexibility will save you money.

4 A BETTER TURBINE

Manufacturing savings from standardization are passed on to you in the form of special features at no extra cost. For instance: hydraulic governing, combined trip-throttle valve, 30% speed range are advantages you'd expect to find only in custom equipment.

Ask your General Electric representative for full details about the DP mechanical-drive turbine or write for bulletin GEA-4955. Get the full details on how standardization will benefit your plant operation. Apparatus Department, General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

252-45

The MONTH...

fied petroleum gas production and distribution, will be in charge of activity under the heading of engineering and research, one of four classifications of staff services which the new department will perform.

Wilson, who has been assistant safety department director, will head accident prevention and fire protection service. The safety office he has conducted in Washington will be closed.

Stroop, in addition to the directorship of the new department, will conduct activities of the general program and coordination services.

Gulf Employes Awards

More than 3766 Gulf Oil Corporation employes will receive awards this month for completing 10 or additional five-year periods of service. Approximately 19,950 or 45 percent of the personnel have achieved this record. Current awards, consisting of a gold emblem, ornamented with a diamond for each 10 years' service and a ruby for an additional five years, plus an engraved certificate, mark the 11th year of presentation.

Sun Oil Executives

James E. Pew, Sun Oil Company, has been elected to fill the vacancy created by William D. Mason, retired, formerly director in charge of industrial relations. Pew is manager of the natural gas and natural gasoline division, production department.

Frank R. Markley was also named member of the board's executive committee and vice president in charge of marketing.

RECEIVES AWARD . . . James H. Pipkin (left), assistant to the chairman of the board of directors of The Texas Company, receives a 1949 honor medal of Freedoms Foundation Inc., Valley Forge, Pa., for "outstanding achievement in bringing about a better understanding of the American way of life." The medal was presented by Dr. Millard C. Faught, consultant to Freedoms Foundation. Pipkin was selected by the 1949 official awards jury of Freedoms Foundation to receive the medal for a speech given by him at Abilene, Texas, in March, 1949, entitled "Is Our Freedom in Danger?"

W. L. Smith

R. B. Smith

Bayes

Archambault

President and Officers Named for Kellogg

Warren L. Smith, former senior vice president, has been elected president of The M. W. Kellogg Company, succeeding Harold R. Austin, retiring. In the newly created post of vice president and general manager is Bennett Archambault, formerly treasurer. Vice presidents named include G. Frank Bayes, Ronald B. Smith, and Zary A. Toula. Dr. William E. Hanford, Alexander Kidd, and Frank Liebrecht are reelected vice presidents. Daniel J. Olsen becomes treasurer and Edwin L. Gidley, secretary.

Austin who has been president of the company since 1944 will continue as consultant to W. L. Smith. Smith, a chemical engineer, has been with the company since 1937. He has served since then as vice president of The Canadian Kellogg Company and later the parent company.

Archambault joined Kellogg in 1946 as engineer. Bayes was formerly director of construction. Ronald Smith joined Kellogg in 1948.

Toula, with headquarters in Paris will guide Kellogg's eastern hemisphere commercial activities. He has been with the company 20 years.

API Board Agrees Oil Must Answer Attacks

The oil industry is under the immediate utmost necessity of resisting the recurring unfair attacks that are being made on it by Washington officials, according to a concensus of API board members at the semi-annual meeting in Houston early last month. Singled out as outstanding illustrations were the Truman administration assault on the 27.5 percent depletion allowance, the "unjustified" opposition to the Kerr Bill amending the Natural Gas Act, and the Cannon resolution proposing a $250,000 monopoly investigation of the industry by the Federal Trade Commission.

Listed as possible forthcoming developments in the industry's information program for 1950 were a closer liaison of oil with other industries for the purpose of resisting the trend towards socialization; allocation of a greater share of the advertising budgets of individual companies to institutional advertising; and an effort by individual company executives to acquaint local newspapers and radio stations with the truth when the industry is under fire in Washington.

"When one knows the industry has done a good job," said Frank M. Porter, recently elected API president, "it is aggravating to have recurring unwarranted assaults on the industry go virtually uncontested." Public opinion of the industry would probably be different if unjustified attacks upon it, such as the multitude of congressional investigations which have marked recent years, had been answered, according to Porter.

Reprint Policy

A change has been made in PETROLEUM REFINER's policy with regard to small, individual orders for reprints of its articles. Since January 1 a charge of 50 cents per copy has been made WHEN REPRINTS ARE AVAILABLE. This will continue.

The charge for tear sheets of a particular article, effective April 1, has been reduced to 25 cents.

Cash or company requisitions should accompany all such "individual" orders.

This change does not affect the price for quantity orders of reprints (starting at 100 orders) which will be quoted upon request.

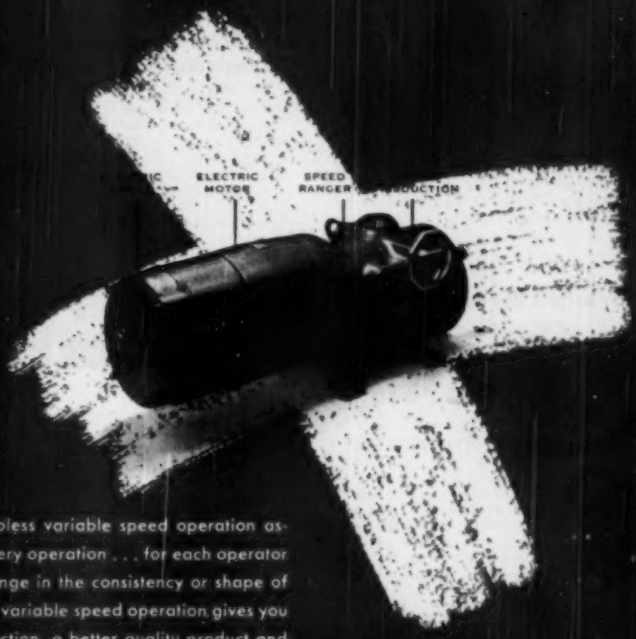
Directors and Officers Named for Western Refiners

Directors of Western Petroleum Refiners Association (April PR, page 174) have been named as follows: R. W. McDowell, Mid-Continent Petroleum Corporation, Tulsa; R. G. Bandy, Midland Cooperative Wholesale, Cushing refining division, Cushing, Okla.; Paul G. Blazer, Ashland Oil & Refining Company, Ashland, Ky.; Reid Brazell, Leonard Refineries, Inc., Alma, Mich.; Rex S. Blazer, Allied Oil, Cleveland, Ohio; H. W. Camp, Cities Service Oil, Bartlesville, Okla.; Sheldon Clark, Sinclair Refining Co., Chicago; O. L. Cordell, Bareco Oil Co., Tulsa; W. J. Carthaus, Deep Rock Oil Corp., Tulsa; F. H. Dunn, Wilcox Oil Co., Tulsa; A. M. Hughes, Phillips Petroleum Co., Bartlesville, Okla.; T. A. Helling, El Dorado Refining Co., El Dorado, Kan.; R. R. Irwin, Socony-Vacuum Oil Co. (White Eagle), Kansas City, Mo.; Harry J. Kennedy, Continental Oil Co., Ponca City, Okla.

J. P. Langfitt, Pure Oil Co., Chicago; R. E. Luton, Ohio Oil Co., Findlay, Ohio; F. L. Martin, Sunray Oil Corp., Tulsa; T. M. Martin, Lion Oil Co., El Dorado, Ark.; Brown L. Meece, Globe Oil & Refining Co., Chicago; Roland V. Rodman, Anderson-Prichard Oil Corp., Oklahoma City; M. H. Robineau, Frontier Refining Co., Cheyenne, Wyo.; R. L. Tollett, Cosden Petroleum Corp., Big Spring, Texas; J. W. Vaiden, Skelly Oil Co., Tulsa; J. W. Warner, Tide Water Associated Oil Co., Tulsa; H. E. Zoller, Derby Oil Co., Wichita, Kan.

Ex-officio directors include H. T. Ashton, Socony-Vacuum Oil Co., St. Louis, and C. M. Boggs, Kanotex Refining Co., Arkansas City, Kan.

Officers are: president, R. W. Mc-



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THE MASTER ELECTRIC COMPANY · DAYTON 1, OHIO

MASTER SPEEDRANGERS

The MONTH...

Dowell, Mid-Continent Petroleum Corporation; vice presidents, F. L. Martin, Sunray Oil Corporation, Tulsa; Roland V. Rodman, Anderson-Prichard Oil Corporation, Oklahoma City; R. L. Tollett, Cosden Petroleum Corporation, Big Spring, Texas; H. E. Zoller, Derby Oil Company, Wichita, Kan.; secretary-treasurer, John C. Day, Tulsa; and general counsel, Fayette B. Dow, Washington, D. C.

"World's Safest Refinery"

The safest of the world's 13 largest refineries is that of Socony-Vacuum Oil Company, Inc. at Paulsboro, N. J., according to a recent National Safety Council rating. With the US average of one disabling injury per year for each of 29 workers, the refinery's record is almost 15 times better or a single disabling accident per year for each 422 workers.

The manufacturing department led the manufacturing departments of every other large oil company in the United States in safety during 1949. The 1949 worldwide contest was won by a company in Netherlands West Indies with Socony-Vacuum second.

AIC Scroll Awarded Texaco Refining Scientist

Dr. Wayne E. Kuhn, manager of the technical and research division of The Texas Company, has been awarded the second honor scroll of the New York chapter of the American Institute of Chemists, "in recognition of his tireless efforts in advancing the chemical profession by writing and lecturing, by discussion and by effective organization."

Kuhn

Kuhn has been with Texaco since 1929 when he joined as a chemist. As manager of the technical and research division, Dr. Kuhn was in charge of all technical and research work for the refining division. He holds a B.A. degree from Reed College, Portland, Ore., and a Ph.D. degree from Cornell University.

John Scott Award Winners

For their contributions to the art of stabilizing cracked gasoline, Dr. Roy C. Story, patent head of Swift & Company, Chicago, and Harry T. Bennett, technical research, Mid-Continent Petroleum Corporation of Tulsa, were recipients early this month, of the John Scott award, presented by the board of directors of city trusts, Philadelphia, at an oil refiners' dinner meeting in Cleveland, Ohio. The award consisted of a copper medal and cash premium of $1000.

Previous recipients include Thomas A. Edison, Orville Wright, and Marie Curie.

Applied Spectroscopy In Armour Symposium

A symposium dealing with the application of spectroscopy in the petroleum industry will be held May 16 at Armour Research Foundation of Illinois Institute of Technology under the sponsorship of the Chicago chapter of the American Association of Spectrographers. Use of the spectroscopic equipment for making highly accurate analyses of substances through the use of light will be discussed. Also included are absorption and emission phases, with technical papers on large-scale production control, laboratory research, and theoretical investigations being planned. Major oil companies and manufacturers of spectroscopic equipment will participate to help survey applications of spectroscopy in the petroleum industry.

Becomes General Petroleum Manufacturing Manager

James H. Curtis has been apointed manager of manufacturing of General Petroleum Corporation, Los Angeles. Previously he had been manager of refineries and assistant manager and manager of the large Torrance, Calif., refinery.

Curtis

Curtis came to General Petroleum in 1942 from The Lummus Company where he had been a process engineer in charge of setting up the initial operations of newly constructed petroleum refineries. He is a graduate of the University of Michigan.

This is Curtis' second advancement in 14 months.

Sun Shipbuilding Elects

Richard L. Burke, vice president of Sun Shipbuilding and Dry Dock Company, has been elected president, succeeding John G. Pew, resigned. John G. Pew, Jr., was re-elected vice president, and Alton A. Norton, superintendent of Hull Construction, was elected vice president. Controller Charles H. Doyle was elected assistant treasurer, and Granville D. Landing named assistant secretary. Others re-elected were J. N. Pew, Jr., chairman of the board, and William Craemer, secretary and treasurer.

Bill Boyd Forms Firm

William R. Boyd, Jr. of Teague, Texas, Major B. A. Hardey of Shreveport, La., and R. L. Wheelock of Corsicana, Texas, have formed the firm of

THE OIL MAN'S CALENDAR

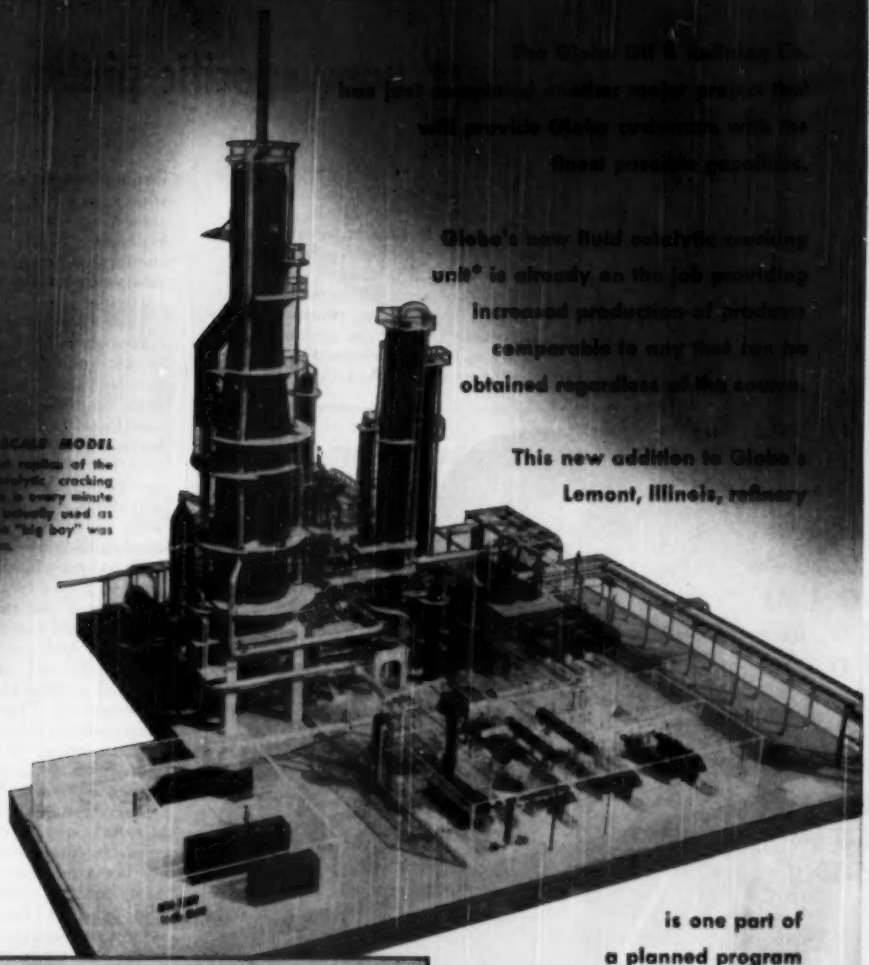
1950 MAY	
15–17	Oil Industry Information Committee, Chicago.
15–18	National Fire Protection Association, Atlantic City, Chalfonte-Haddon Hall.
15–18	National Fire Protection Association, American Gas Association Exhibit, Atlantic City, N. J., Haddon Hall.
22–24	American Gas Association, Production and Chemical Conference, New York, Hotel New Yorker.
25–26	Natural Gas and Petroleum Assn. of Canada, Annual Convention, Windsor, Ont., Can., Prince Edward Hotel.
29–31	Texas College of Arts and Industries, Fifth Annual Short Course in Gas Technology, Kingsville, Texas.
JUNE	
4– 9	Society of Automotive Engineers, Summer Meeting, French Lick, Ind., French Lick Spring Hotel.
8–10	National Society of Professional Engineers, Annual Meeting, Boston, Hotel Statler.
12–16	American Institute of Electrical Engineers, Summer and Pacific General Meeting, Pasadena, Calif., Huntington Hotel.
12–16	American Society of Mechanical Engineers, Oil and Gas Power Division, Baltimore, Md., Lord Baltimore Hotel.
12–16	American Society of Mechanical Engineers, 4th National Materials Handling and Exhibit, Chicago, International Amphitheater.
15–16	Pennsylvania Grade Crude Oil Association, Annual Meeting, Pittsburgh, Hotel William Penn.
18–20	Petroleum Equipment Suppliers Association, White Sulphur Springs, W. Va., The Greenbrier.
26–30	American Society for Testing Materials, 53rd Annual Meeting, 9th Exhibit of Testing Apparatus and Related Equipment, Atlantic City, N.J., Chalfonte-Haddon Hall
JULY	
3– 8	Institute of Petroleum, Second Oil Shale and Cannel Coal Conference, Glasgow, Scot.
AUG.	
14–16	Society of Automotive Engineers, West Coast Meeting, Los Angeles, Biltmore Hotel.
1950 SEPT.	
3– 8	American Chemical Society, Chicago.
5– 9	American Chemical Society, 6th National Chemical Exposition by Chicago Section, Chicago, Chicago Coliseum.
11–15	American Society of Mechanical Engineers, Industrial Instruments and Regulators Conference with the Instrument Society of America, Buffalo, N. Y., Municipal Auditorium.
13–15	National Petroleum Association, Atlantic City, N.J., Hotel Traymore.
18–22	Instrument Society of America, National Confernece and Exhibit, Buffalo, N.Y., Memorial Auditorium.
25–27	American Society of Mechanical Engineers, Petroleum Mechanical Engineering Division, New Orleans, The Roosevelt.
OCT.	
1– 3	Independent Petroleum Assn. of America, Annual Meeting, St. Louis, Mo.
2– 6	American Gas Association Annual Convention, Atlantic City, N.J.
15–20	Oil Progress Week.
16–20	National Safety Congress, National Safety Council Exposition, Chicago.
30 to Nov. 1	National Lubricating Grease Institute, Annual Meeting, Chicago, Edgewater Beach Hotel.
NOV.	
2– 3	Society of Automotive Engineers, Diesel Engine Meeting, Chicago, Hotel Knickerbocker.
9–10	Society of Automotive Engineers, Fuels and Lubricants Meeting, Tulsa, Okla., The Mayo.
11–13	Oil Industry Information Committee, Los Angeles, Biltmore Hotel.
13–16	American Petroleum Institute, 30th Annual Meeting, Los Angeles, Biltmore Hotel and Ambassador Hotel.
13–17	National Electrical Manufacturers Association, Atlantic City, N.J., Chalfonte-Haddon Hall.
26 to Dec. 1	American Society of Mechanical Engineers, New York, Hotel Statler.
DEC.	
3– 6	American Institute of Chemical Engineers, Annual Meeting, Columbus, Ohio.

GLOBE'S CAT CRACKER GOES TO WORK!

The Globe Oil & Refining Co. has just completed another major project that will provide Globe customers with the finest possible gasolines.

Globe's new fluid catalytic cracking unit* is already on the job providing increased production of products comparable to any that can be obtained regardless of the source.

This new addition to Globe's Lemont, Illinois, refinery



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CHICAGO

28 refinery tested analyses

to meet your specific piping problems

Here are

Low Carbon
Low Carbon, ½ Mo
Low Carbon, 1 Mo
½ Cr, ½ Mo
1 Cr, ½ Mo
1-¼ Cr, ½ Mo
2 Cr, ½ Mo
2 Cr, ½ Mo, 1-¼ Si
2-¼ Cr, 1 Mo
2-½ Cr, ½ Mo, ¾ Si
3 Cr, ½ Mo, 1-¼ Si
3 Cr, 1 Mo
5 Cr, ½ Mo
5 Cr, ½ Mo, 1-½ Si
5 Cr, ½ Mo, Ti
7 Cr, ½ Mo
8 Cr, ½ Mo
8 Cr, 1 Mo
9 Cr, ½ Mo
9 Cr, 1 Mo
12 Cr, Al
17 Cr
27 Cr
18-8
18-8 Ti
18-8 Cb
18-8 Mo
25-20

NO matter how unusual your pipe or tube problem, there's a good chance that one of our 28 analyses will solve it. But the important thing to remember is this: each of these analyses was developed to overcome actual conditions of corrosion, oxidation, temperature, pressure, and exposure. In addition, each of these analyses has been thoroughly tested in refinery service. As a result of these installations, we've found out exactly what each will do. And we discovered something else, too: it takes a lot of experience before any one analysis can be recommended as the best and most economical pipe or tube for any particular job.

We've got that experience. Because National Tube Company — world's largest manufacturers of seamless tubular products—has spent over 60 years building up a file of authentic case histories. The endless miles of National Seamless Pipe and Tubes *now in use* have given us a first-hand opportunity to observe the actual performance of refinery tubes under some of the most trying operating conditions known to the industry.

But there's more to refinery tubes than steel analyses. The mechanical strength of the tube is vitally important—and you can't beat seamless tubes for strength. All National refinery pipe and tubes are seamless. They're pierced from billets of high quality steel. This method of manufacture—one of the most drastic forging operations in the industry—assures you of tubes that have absolutely uniform wall strength.

So remember, if you want the best results from your tubes, at the lowest possible cost, submit your problems to our engineers *before* you select new tube requirements. Our huge file of case histories . . . the experience of our engineers . . . are at your service. For more information, write National Tube Company, Frick Building, Pittsburgh 19, Pa.

NATIONAL TUBE COMPANY, PITTSBURGH, PA.
(Tubing Specialties Division)
COLUMBIA STEEL COMPANY, SAN FRANCISCO
PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL

The MONTH...

Boyd, Hardey & Wheelock, to engage in activities and operations limited to the initiation and conduct of negotiations for the purchase or sale of oil or gas producing properties, and for the merger of oil or gas companies or individually owned oil or gas interest. Headquarters will be located in Teague with Boyd serving as managing partner.

Boyd is past president of the API, Hardey an independent producer of oil and gas and former president of the IPAA and Wheelock served as president of the Texas Petroleum Council during its existence and is a member of the oil producing firm of Wheelock & Collins.

Up for Directorship Standard of New Jersey

Henry H. Hewetson has been designated as a nominee for election as a director of Standard Oil Company (New Jersey) which he joined as a student engineer at the Sarina, Ont., refinery of Imperial Oil Limited, Jersey affiliate. From his first full-time job of stoking a coal-burning still, Hewetson rose to be president and later chairman of Imperial. He has worked with the Linden labs and was formerly vice president and general manager of Esso Standard Oil Company's Baton Rouge, La., refinery. From 1935 to '38 Hewetson reviewed marketing operations in Europe and South America and later becoming head of Imperial's marketing department.

Hewetson

Robert T. Haslam, a vice president and a director of Standard Oil Company (N. J.), who plans to retire in the fall, has asked not to be a nominee for re-election as a director. Haslam joined Jersey Standard in 1927.

Texaco and Striking Unions Sue for Breach of Contract

A damage suit in excess of $500,000 against the Oil Workers International Union (CIO), Port Neches Local 228, and officers and agents of both unions has been filed by The Texas Company in a Beaumont, Texas, federal court. Charges are that the international and local officers and agents of the two unions violated the labor agreement when they called a strike.

A similar suit was filed by Texaco against the OWIU (CIO) and its Lockport Local 222 in Illinois. Approximately $1.1 million damages are sought there.

It was stated that in both suits charges are directed not against employes but rather the international and local unions and their officers.

In a $2 million counter suit against The Texas Company, the OWIU (CIO) is asking damages for alleged breach of contract at the Port Neches, Texas, refinery. Charges are that the existing contract at the Port Neches plant provides for notice in the event of a "lockout" by the company and that no such

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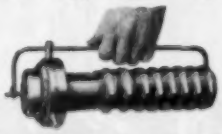
OF SHORT NIPPLES

. . ."This RIDGID nipple chuck sure cuts the monkey-business out of threading short nipples."

New RIDGID Nipple Chuck fits any threading machine, power drive or vise

● Typical RIDGID worksaver advantages in this new nipple chuck—to speed every short nipple threading job! Fits any threading machine, power drive or vise—no special tools, parts or adjustments. No adjusting or changing of stop plug—it's an integral part of nipple chuck—automatically in position for use. Threaded nipple is released instantly by turn of nipple chuck—easily unscrewed by hand. Pipe adaptors for ¼" to 1½", chuck takes 2" pipe. Ask for this new fast efficient nipple chuck at your Supply House.



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another important project

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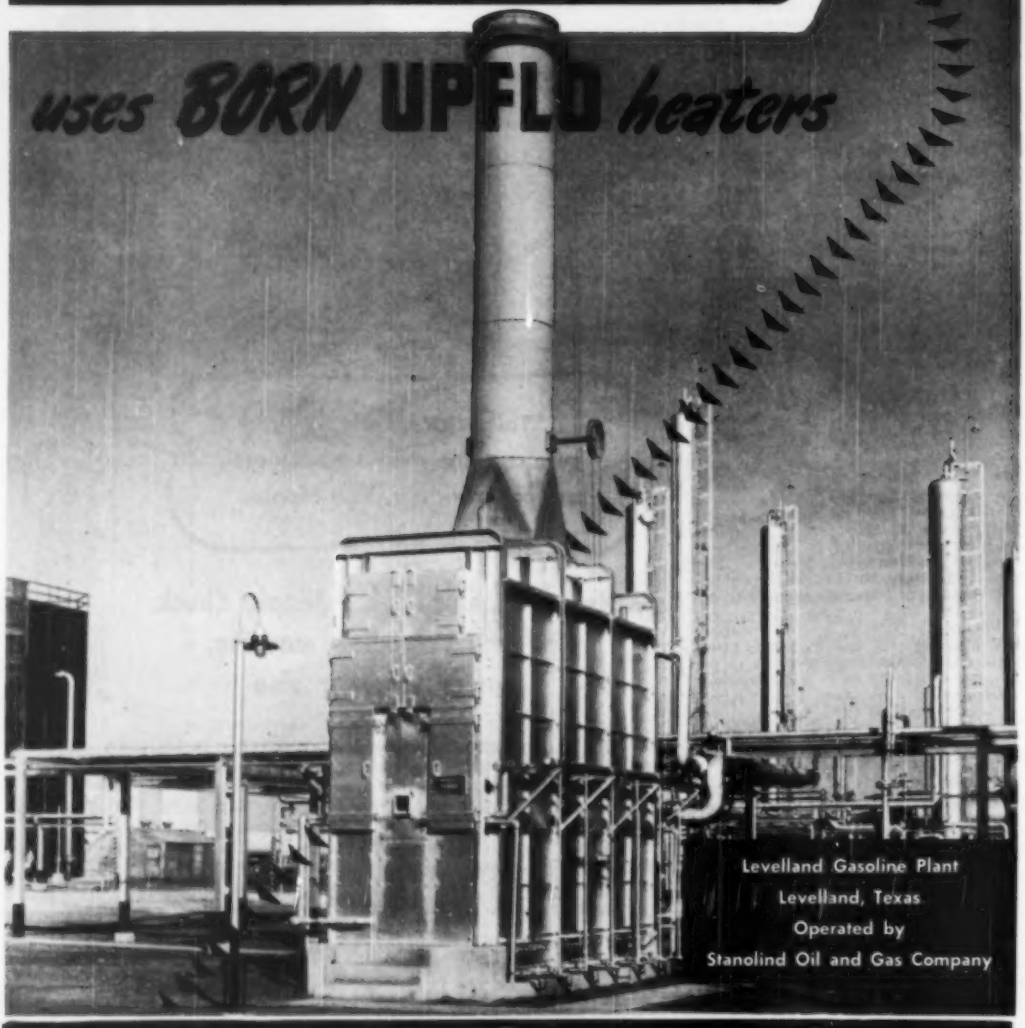

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Levelland, Texas
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TULSA, OKLAHOMA

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HOUSTON, TEXAS, Sales Engineering Co. of Houston, Inc. — NEW YORK, N. Y., Richard Morton
Canadian Associates: BRANDON, MANITOBA, Canadian Brown Steel Tank Co., Ltd.

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

Trends in Week Ended	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1949:									
January 29	5,493	5,490	255,450	17,531	114,677	7,547	63,142	8,178	63,333
February 26	5,401	5,412	261,965	17,621	124,382	7,430	54,006	8,225	56,348
March 26	5,188	5,353	266,506	17,417	128,087	6,167	48,721	8,305	58,792
April 30	4,980	5,272	271,355	17,969	124,787	6,681	49,950	8,185	60,174
May 28	4,981	5,297	275,190	18,324	120,661	5,943	55,971	8,144	63,756
June 25	4,944	5,322	274,114	18,462	115,715	5,148	63,049	7,856	66,146
July 30	4,731	5,187	271,999	18,058	109,964	6,293	70,767	7,205	67,166
August 27	4,769	5,215	266,455	18,180	106,280	6,491	74,718	7,597	68,394
September 24	4,933	5,377	259,189	18,152	103,262	6,555	81,414	7,419	68,143
October 29	5,075	5,509	252,069	19,002	103,915	7,016	90,358	7,754	69,459
November 26	5,192	5,331	256,409	18,204	104,917	6,971	91,795	8,104	67,067
December 24	4,955	5,482	256,830	18,045	110,164	7,335	78,662	8,046	61,847
1950:									
January 28	4,956	5,470	248,411	18,363	124,270	7,302	66,337	8,389	57,036
February 25	5,000	5,277	245,586	17,703	133,888	6,990	56,050	7,855	48,663
March 25	4,848	5,469	244,227	17,839	135,406	6,870	40,577	8,171	42,546
April 29	5,014	5,314	*244,111	18,038	128,655	6,531	36,695	7,272	39,260

* April 22, Stocks.

notice was given. The OIWU contends that the situation at Port Neches, Port Arthur, Texas, Lockport, Ill., and Casper, Wyo., was shifted from strike to lockout status when Texaco refused to admit workers seeking to return to their jobs.

API Will Publicize Synthetic Fuels Costs

As an answer to recent government claims, the API board of directors last month assigned to API's refining committee the task of developing industry figures on the basic costs of producing synthetic liquid fuels from coal and oil shale. There was no formal vote, but agreement followed discussion begun by John R. Suman, Standard Oil Company (New Jersey), who urged a need for the industry to develop cost figures in answer to those developed by the Interior Department.

ASA Activities Revealed In Report and Chart

Rapidly growing importance of American Standards Association as a factor in American industrial economy, in the quality and cost of industrial and consumer goods, and in public safety is reflected in a report and chart just issued by ASA. These show that the number of new and revised American Standards approved during 1949 was almost double the average number approved annually during speeded-up activity of five war years. More than five times as many standards were approved in 1949 as the annual average for the first 13 years of the association's operation.

The 268 approvals last year bring the total number of American Standards to 1121 and total revisions to 1014. (New developments in materials and methods, new experience, and improvements or changes in conditions require constant revisions.)

Included in the approved standards are 70 for the chemical industry, 46 for petroleum (test of products), 130 for industrial safety and health, 5 for welding, 150 for industrial and public safety and many others.

ASA, a federation of 101 national organizations (technical societies and trade associations), was organized as a clearinghouse to coordinate multiple standardization activities and to avoid duplication of effort and divergent standards. Membership also includes 2000 industrial firms.

ASA policy and procedures are controlled by 68 organization members. Organization membership has increased nearly 30 percent since 1938.

Canada Ups Expenditures

Canada's oil industry will spend $300 million in 1950 for new refinery capacity, exploration, pipe lines, and tankers. This predicted amount is three times as much as in 1949, according to G. L. Stewart, president Imperial Oil Company. The figure represents about 10 percent of the total private capital expenditures that are expected to be made in Canada this year.

The MONTH...

International Harvester Executive Is UOP Director

General Levin H. Campbell, Jr., executive vice president of International Harvester Company, has been elected to the board of directors of Universal Oil Products Company, Chicago. General Campbell is an honorary life member of the American Society of Mechanical Engineers and holds the honorary degree of doctor of laws of the University of Arkansas. He is a director of Metropolitan Body Company, American Steel Foundries, and International Harvester of Canada. Other positions held are trusteeship in the Illinois Institute of Technology and membership in the executive committee of Armour Research Foundation.

Campbell

General Campbell has been with International Harvester since 1946.

General Petroleum Makes Torrance Changes

Richard E. Lauterbach has been named assistant manager of General Petroleum Corporation's Torrance refinery with Paul Sanders new general superintendent.

A veteran of nearly 31 years with General Petroleum, Sanders has been refinery superintendent since 1945. Lauterbach joined in 1936 as a laboratory assistant. Successively he has been chemical engineer and refinery engineer.

Opens Consultant Offices

Richard E. Hulme, formerly with the development department of Diamond Alkali Company at Painesville, Ohio, has resigned to open a consulting office in Bradford, Pa. Hulme and his associates will specialize in problems dealing with the heavy chemical, petrochemical, petroleum and the process industries in both the design and economic evaluation phases. In his six years with the company he has developed a magnesium oxide process, and methods of dehydrating caustic soda and recovering liquid chlorine from purge gas.

During the war Hulme was employed as a process design engineer with Blaw Knox Company, Pittsburgh, being a member of the engineering team responsible for the basic design of the Copolymer synthetic rubber plants. Previously he had been associated with Kendall Refining Company as assistant chief engineer at their refinery at Bradford.

Harry Klein Honored

New York University last month conferred upon Colonel Harry T. Klein, president of The Texas Company, the honorary degree of doctor of commercial science. Colonel Klein holds an

ALCOA

Alcoa Heat Exchanger News

PUBLISHED BY THE ALUMINUM COMPANY OF AMERICA

CUT TUBE COSTS AS MUCH AS 80%

Depending on the kind of tubes you now use, savings of 30%, 50% and even 80% are yours by switching to Alcoa Aluminum Heat Exchanger Tubes. These percentages are actual price comparisons . . . foot for foot, metal for metal at the retail levels. If yours is an average-sized refinery, you can save about $50,000 in a single year.

No trick to rolling-in ductile Alcoa Tubes. Standard tools and equipment are all you need. And you'll find aluminum's lightness eases handling and speeds fabrication.

Alcoa Tubes have been on the job for 18, 20, even 25 years without replacement. Their corrosion resistance to ammonia, hydrogen sulfide, carbon dioxide and other contaminants saves you maintenance and repair expense. Alcoa Alclad Tubes successfully resist most cooling waters. They handle steam up to temperatures slightly above 400°F. And in sub-zero processes down to −320°F, and lower, they increase in yield and tensile strengths, show no signs of embrittlement.

For complete information about Alcoa Tubes and the name of your nearest supplier, call your local Alcoa sales office. Or write ALUMINUM COMPANY OF AMERICA, 1494E, Gulf Building, Pittsburgh 19, Pennsylvania.

* * *

ALUMINUM COMPANY OFFERS NEW BOOK

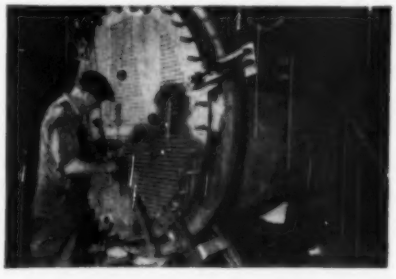
This new, 24-page booklet will answer many of your questions about Alcoa Tubes. It covers fabrication techniques . . . alloy selection . . . applications both chemical and petroleum. It describes tube cleaning, the use of inhibitors and methods of cathodic protection. It contains complete information on fluid flow and heat transfer characteristics, plus tables of physical properties and specification data. Write for your free copy, today. ALUMINUM COMPANY OF AMERICA, 1494E Gulf Building, Pittsburgh 19, Pennsylvania.

ALUMINUM TUBES EXTEND SERVICE OF COMPRESSOR AFTERCOOLERS

The Ashland Oil & Refining Company of Catlettsburg, Ky., uses Alcoa Tubes in their booster compressor aftercoolers operating at 440 psi and 250°F. The product consists of light hydrocarbon gases with traces of ammonia and hydrogen sulfide. River water is used for cooling. The aluminum tubes are rolled into carbon steel tube sheets with the water-side faces zinc metallized. This procedure provides excellent cathodic protection to the aluminum tubes, although Alclad 4S-F Alloy Tube Sheets would often be recommended.

Installations of this type using Alcoa Tubes have been operating continuously for several years without any sign of corrosion failure. Many utilize salt water for cooling.

TUBING WITH ALCOA ALUMINUM



Aluminum tube sheets should be used wherever possible. For best corrosion resistance, use Alclad 4S-F Alloy Plate. For high operating pressures, use high tensile strength 61S-T6 Alloy Plate.

Existing commercial practices should be followed for tube hole spacing. Grooved tube holes afford tighter tube joints, but are not necessary. Standard tools and techniques are used for rolling-in Alcoa Tubes.

The use of steel tube sheets is satisfactory in many fresh, cooling waters. If necessary, cathodic protection may be provided in the form of zinc strips or zinc metallizing of the tube sheets.

It is not recommended that aluminum tubes be used with copper alloy tube sheets, because of galvanic corrosion which can occur.

Complete fabrication, installation and service information is contained in Alcoa's new booklet, "Alcoa Aluminum Heat Exchanger Tubes". Write for your free copy.

The MONTH...

LL.B. degree from McDonald Institute (YMCA night law school). He practiced and taught law in Cincinnati from 1909 to 1917, becoming connected with The Texas Company in New York in 1921 as assistant general counsel. Four years later he was appointed general counsel. In 1933 Colonel Klein was elected a director and vice president of the company.

Presentation of the doctorate to Colonel Klein and 49 other business and financial leaders climaxed a two-day conference marking the 50th anniversary of New York University's school of commerce, accounts, and finance.

ASA Elects Olmsted

Election of C. E. Olmsted, New York, as a director, has been announced by the American Standards Association. Olmsted is vice president and director of The Texas Company and a member of the API. He was with The Texas Company in Los Angeles for 15 years before coming to New York.

Olmsted

Olmsted has been associated with the oil refining, transportation, marketing, and production phases of the industry.

In his oil activities, Olmsted has been in close touch with the extensive standardization of equipment, production practice and test methods used by the industry.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

β—Fluoropropionic acid
Sodium cyclohexanesulfonate
3-Aminophenol
Carbamyl bromide
4-methyl-1,3-dioxane
2-Phenyl-n-propylamine
Di-n-butyl formal
Dodecyltriethylammonium bromide
2,6-Dimethylheptanetriol (2,4,6)
para-Nitro-ω-bromoacetophenone
2-Hydroxy-4-aminonaphthalene
Tetramethylethylene
10-Nonadecanone
2-Ethylthiacyclopropane
2-Thiaheptane
2-Hexanethiol
2-Methyl-1-butanethiol
Cyclohexylcyclopentane
2,6-Difluoro-para-xylene

New Lapel Pin for LPGA

A blue gas flame is the central motif of the new lapel pin announced by the Liquefied Petroleum Gas Association. The emblem is made of gilders metal

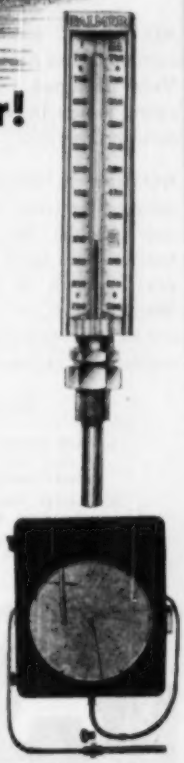
The word "gets around"...

about a good thermometer!

YES, literally 'round the world has gone the reputation of Palmer Thermometers. Inquiries read like a Cook's Tour . . . Rome, Singapore, Oslo, Melbourne, Rio de Janeiro and points east, west, north and south!

There's a reason! Unswerving accuracy and dependability—basic for a good thermometer—head Palmer's list of quality features. When you add rugged construction, streamlined appearance, famous "Red-Reading-Mercury" . . . it's easy to see why refineries, dairies, process industries,—practically every branch of international industry—respect Palmer's quality.

If you aren't familiar with Palmer indicating and recording thermometers, we'd like the word to "get around" to you. Write for complete catalog.



PALMER THERMOMETERS INC.

Mfrs. of Industrial, Laboratory, Recording and dial Thermometers
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Canadian Plant: King & George Sts., Toronto 2

The MONTH...

and is silver plated. It is available with a button-back attachment for men and with a safety lock catch for women.

Prices run from 50 cents each to as low as 40 cents each for large quantities.

Retires After 43 Years

H. W. Prentis, Jr., president of Armstrong Cork Company, has retired after 43 years with the company with which he has served as advertising manager, general sales manager of the floor division, member of the board of directors, and vice president.

Refiners Must Aid in Marketing Natural Gasoline; Award to Katz

The increased production of natural gasoline presents a problem to the refining industry as to whether they should use it in their processing or allow it to seek out markets which are as a rule detrimental economically to their markets. "This production must and will find a market," James E. Pew (Sun Oil Company) president of the Natural Gasoline Association of America said in opening the association's 29th annual convention in Fort Worth, Texas, April 24. Approximately 1000 members of the industry were present.

Pew outlined the factors responsible for the unbalance of the natural gasoline supply and demand situation as continuing pressure exerted by state conservation commissions, backed by authoritative court decisions, to eliminate flaring natural gas; the loss of foreign markets due to England's devaluation of the pound, and the loss of domestic markets due to closing of some smaller refineries.

"While the production of natural gasoline is small in comparison with the total production of gasolines, the location of this production can exert considerable effect on the refining industry's markets if the producers are forced into the finished motor fuel business by the lack of demand by the refiners," Pew said. He pointed out that free markets and competition are excellent testing grounds for a commodity's real worth, and that this is the period the natural gasoline industry is going through today. Refiners, he said, who have the vision to see the potentialities of natural gasoline will be the gainers.

Threat to Conservation

B. R. Carney, Warren Petroleum Corporation, Tulsa, told the convention that natural liquids are now 13 percent of America's liquid petroleum reserves—a fact that many refiners do not know or simply ignore. As a result, there is extreme weakness in the markets for these liquids, a condition which threatens the conservation efforts of the oil and gas producing states, he said.

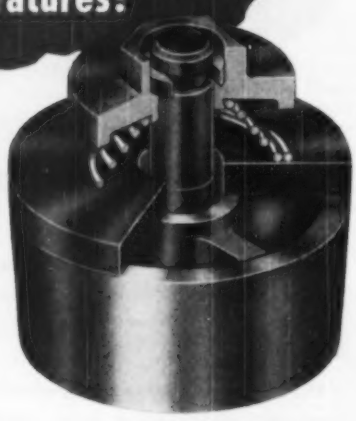
Only refiners can make optimum use of the bulk of natural gas liquid production, Carney said, and pointed out that about 70 percent of available natural gas liquids should move to markets through refiners. Using this figure as a basis, refiners can plan to use natural gas liquids for 6.5 percent of their total raw material at present, and increase to 9 percent or higher in the next few years. Otherwise, natural gas liquids will increasingly seek direct market outlets at whatever prices can be realized.

K. W. Rugh, manager of the Philgas Division, Sales Department, Phillips Petroleum Company, reported that in 1949 LP-gas marketed was 2725 million gallons—and this does not include that portion used in the manufacture of synthetic rubber, aviation gasoline, or other gasoline. However, of this market figure, 525 million gallons were used in chemical manufacturing, 240 million gallons for gas manufacturing, 310 million gallons as industrial fuel, and 1-65 million gallons were sold directly as a fuel for homes and farms, he said. This volume, Rugh added, amounts to about 20 gallons for every man, woman, and child in the United States.

Rugh discussed several markets for LP-gas, that are being developed as rapidly as possible, which over a period of years will assist in a leveling off of demand. Currently, he said, the most important new use for LP-gas is fueling farm tractors. Such use is being met with good success and increasing acceptance. Use of LP-gas is being expanded for fueling city bus lines, large truck lines, off-the-highway construction equip-

American Iron Reciprocating Pump Valves are

HIGHLY RESISTANT to Corrosion and High Temperatures!



NO threaded connections to corrode in this American Iron Valve designed for reciprocating pumps in refinery and industrial service!

NO steel to corrode! Constructed entirely of bronze and phenolic, for operating temperatures up to 300°, and pressures up to 750 psi.* Manufactured for all standard reciprocating pumps using replaceable valves.

EACH PART HIGHLY EFFICIENT!

1. Hard, bronze alloy 3-web seat is cast with center guide as integral part.
2. Phenolic valve plate is highly resistant to both chemical action and high temperatures.
3. Conical valve spring offers only 6 to 8 lbs. resistance; compresses to 1/8-in. for greater valve lift in all pumps.
4. Valve and spring retainer is recessed to prevent damage to conical spring when valve plate is fully opened.
5. Easily assembled by use of retainer keeper. There are NO threaded connections.

*For higher temperatures up to 950°F, we recommend our all-stainless steel valve and seat of the same design.

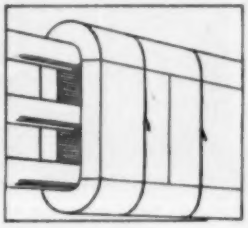
AMERICAN IRON & MACHINE WORKS CO.
Oklahoma City, Okla.— Box 1177— Phone L. D. 518
District Office: Houston, Texas
Export Office: 11 West 42nd St., New York City

What's wrong with this picture?

This man is insulating these exposed water tubes the hard way. He's covering each tube separately, instead of insulating the group as a single unit. When boiler tubes, or any other group of hot lines, operate at the same temperatures and are as close together as these, it takes less time and less material to insulate them as one unit. This method is shown in the small illustration below. It also cuts down the area of exposed insulation surface, thus reducing the amount of heat lost by radiation.

Half sections of pipe covering are used on the outside lines, then all lines are boxed in together with insulating block. Of course, if the lines are spaced too far apart, or if they must be readily accessible for maintenance, each line should be insulated separately.

Sometimes whether to insulate piping singly or as a unit may be a pretty close decision. At other times, the answer may be obvious. But there is always one best way of doing this job, just as there is for every other phase of heat insulation work.



In cases like this, Armstrong engineers are trained to recommend the least expensive and most efficient methods. The complete contracting service they represent also supplies you with top-quality insulation materials and sundries, applied by skilled Armstrong installation crews.

If you consult an Armstrong engineer the next time you plan a heat insulation job, his advice may save you time and money. His services are always available without obligation. Call the Armstrong office nearest you or write to Armstrong Cork Company, 7505 Maple Ave., Lancaster, Pa.

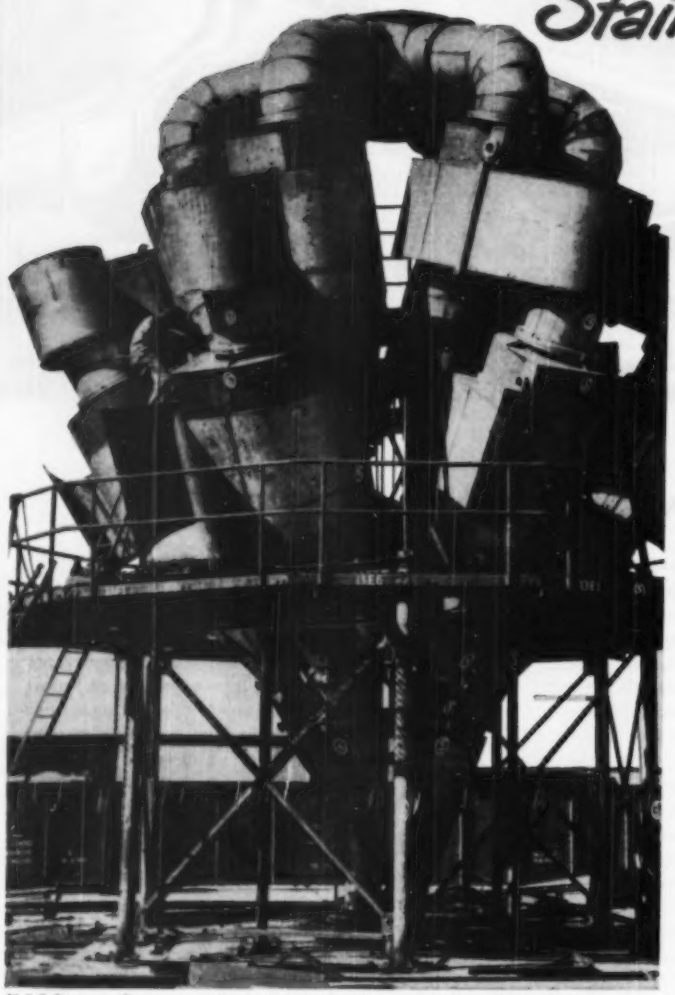
ARMSTRONG'S INDUSTRIAL INSULATIONS

MATERIALS - INSTALLATION

FOR ALL TEMPERATURES FROM 300°F. BELOW ZERO TO 2800°F.

THE MORE SEVERE THE SERVICE

—the greater the need for Stainless Steel



U·S·S Stainless Steel was used extensively in the fabrication of this Buell Van Tongeren catalyst collector by the Wyatt Metal & Boiler Works, Houston, Texas.

There are three important reasons why the petroleum refining industry turns to U·S·S Stainless Steel to meet its most severe corrosion problems:

- **No other commercial metal can equal Stainless Steel in its high resistance to so many different types of corrosives.**
- **Stainless Steel is unsurpassed for retaining its strength under extremely high temperatures.**
- **U·S·S Stainless Steel is available in a wide range of analyses, and in many different forms — sheets, strip, plates, wire, bars, pipe and tubing. As a result, it will meet almost any fabricating requirement and service condition.**

The many outstanding advances and the immense expansion program undertaken by the refining industry in recent years have placed unusual and increasingly stringent demands on processing equipment. But Stainless Steel has kept pace, meeting these new conditions with corrosion-resisting and heat-resisting analyses that yield outstanding performance under today's requirements.

In all types of jobs . . . in all types of equipment . . . Stainless Steel is holding equipment deterioration to a minimum and keeping down costly product losses.

U·S·S Stainless Steel is a perfected, service-tested material, uniform in finish and in fabricating qualities. Our engineers, specialists in Stainless and its application, will be glad to work with you in selecting the grade of Stainless that will give you the ultimate in performance.

AMERICAN STEEL & WIRE COMPANY, CLEVELAND · CARNEGIE-ILLINOIS STEEL CORPORATION, PITTSBURGH
COLUMBIA STEEL COMPANY, SAN FRANCISCO · NATIONAL TUBE COMPANY, PITTSBURGH · TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM
UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

U·S·S STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

UNITED STATES STEEL

The MONTH...

ment and other internal combustion engines.

Rugh said it appears certain that increases in LP-gas gallonage sales will be made to new markets and expansion of existing ones.

Hanlon Award

The Hanlon award, highest honor in the natural gasoline industry and one of the ranking awards of the entire petroleum industry, was conferred by NGAA President James E. Pew on Dr. Donald L. Katz, professor of chemical engineering, University of Michigan. Dr. Katz is the fourteenth recipient of the award, which is conferred each year for outstanding service to the natural gasoline and cycling industries.

Katz

The citation presented Dr. Katz stated in part that "Over a period of years Dr. Katz has been a tireless researcher on phase behavior of hydrocarbons and his reports on this subject have been of great assistance in the understanding of separation processes and reservoir behavior. His publications on critical phenomena and retrograde condensation helped to clarify a complex subject for industry. As a research engineer, teacher, and writer, he has made outstanding contributions to the scientific knowledge of the oil industry and his basic information on hydrocarbons has guided engineers in the design and operation of plants, not only because of its reliability but because it was always presented in a manner which was readily understood and immediately useable by the practicing engineers who needed it most."

Program Participants

Chairmen of the different convention sessions include R. A. Worley, The Parade Company, Shreveport; Willard G. Wiegel, Lone Star Gas Company, Dallas; and W. F. Matheny, Sid Richardson Gasoline Company, Fort Worth.

The panel of experts for the "Information Please" session included J. B. Taylor, Signal Oil & Gas Company, Los Angeles, and president, California Natural Gasoline Association; T. O. Kuivinen, Cooper-Bessemer Corporation, Mt. Vernon, Ohio; W. S. McAllister, Warren Petroleum Corporation, Gladewater, Texas; H. R. Legatski, Phillips Petroleum Company, Bartlesville; M. V. Cousins, United Gas Company, Shreveport; Mark Patton, Hurley Gasoline Sales Company, Tulsa; Will Swerdloff, Magnolia Petroleum Corporation, Dallas; S. S. Smith, Shell Oil Company, New York; Glenn O. Wynn, Mid-Continent Petroleum Corporation, Tulsa; Dr. D. L. Katz, University of Michigan, Ann Arbor; D. A. Klemme, Stanolind Oil & Gas Company, Tulsa, and W. J. Murray, chairman of the Texas Railroad Commission, Austin. Moderator for the panel was J. H. Dunn, president, The Shamrock Oil and Gas Corporation, Amarillo.

All officers of the association were re-elected for 1950-51. President is James

with

RUST-OLEUM

Rust can be stopped . . . stopped easily, surely, economically! RUST-OLEUM is the answer. For 25 years it has proved its capacity to stop and prevent rust at sea, in the oil fields, in fume-choked industrial areas, on railroad rolling stock, bridges and signaling equipment.

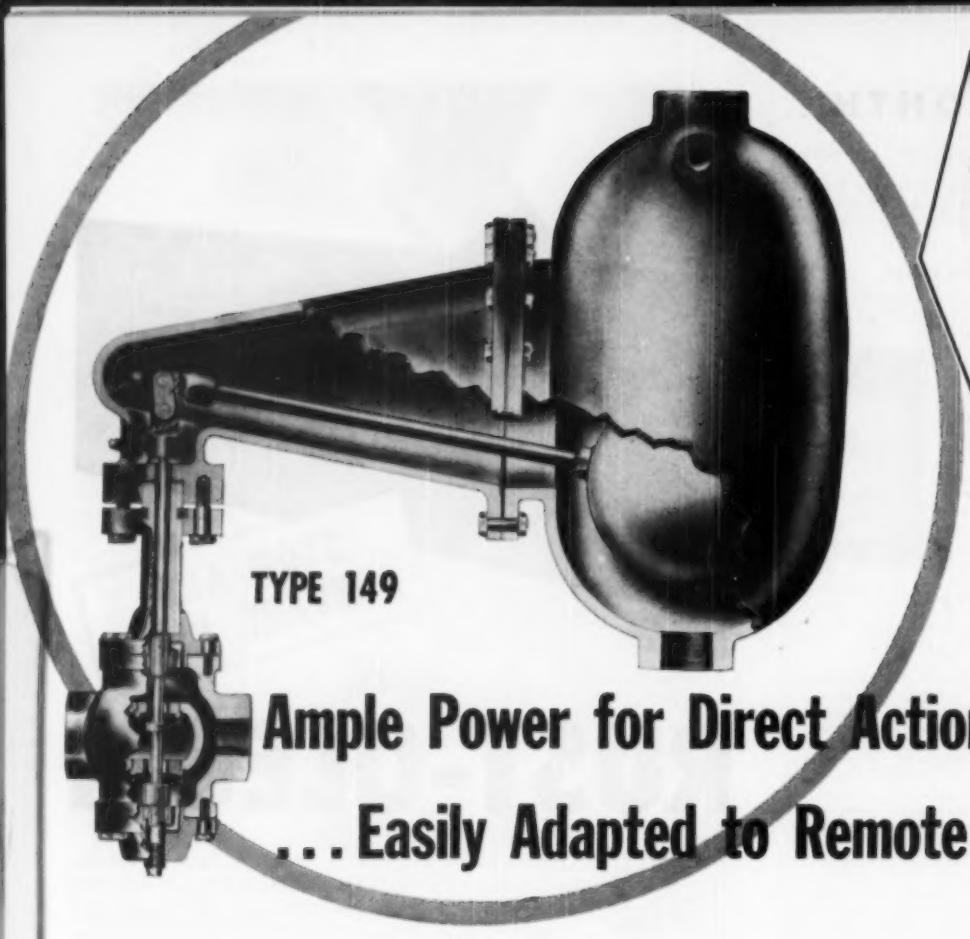
RUST-OLEUM . . . an exclusive formula . . . protects metal with a tough, long-lasting pliable film that dries to a hard, firm finish that defies rain, snow, salt air, fumes and weathering. It adds years of extra use to refinery equipment, metal roofs, petroleum tanks, fences, stacks, gutters, downspouts, machinery and other metal surfaces.

RUST-OLEUM decorates as well as protects. It is available in all colors, aluminum and white. It can be applied to metal where rust has already started. You don't have to remove all the rust.

RUST-OLEUM is stocked and sold by Industrial Oil Field and Industrial Distributors in most principal cities. See our complete catalog in Sweets, or write for full information.

RUST-OLEUM CORPORATION

2551 Oakton Street • Evanston, Illinois



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Ample Power for Direct Action ... Easily Adapted to Remote Control

For Quick Solutions of Tough Problems, Count on *Climax!*

You'll be amazed at the ease with which a BS&B Controls Engineer can end your control worries. Strategically located, he is always ready to give you complete, understanding service... in strict confidence. Check the coupon below for the BS&B Controls Man nearest you.

You have a leverage ratio of 18 to 1 forming the connection between float and inner valve plug in the valve body of the BS&B-Climax 149 Feed Water Regulator. This means ample power to operate against differentials across the valve as usually encountered. Designed to serve as Feed Water Regulator or as Liquid Level Control. Combines the economy with the proved efficiency of Climax top-and-bottom-guided, reversible valve bodies.

Employ the type 149 float cage for direct control of level, remote of valves or instruments through air pilots, and operation of alarm systems or signals through Mercoid switches. Yes, sir... you can't beat this BS&B-Climax Control for versatility!

BLACK, SIVALLS & BRYSON, INC.
Climax Controls Division, Section C1-23-5
720 Delaware Kansas City, Mo.

Send complete information on following items, as checked: ☐ Type 149 Feed Water Regulator ☐ Type 320 Pressure Reducing Regulator ☐ Type 98 Diaphragm Valves ☐ Type 850 Displacement Liquid Level Controllers ☐ Have Sales Engineer call. Also send name of nearest BS&B Controls Man.

NAME_____

TITLE_____

COMPANY_____

STREET_____

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Models available... in high tensile cast iron for pressures up to 250 psi, cast steel for up to 500 psi.

Complete description, diagrams, specifications and applications are ready for you. Mail the coupon... today!

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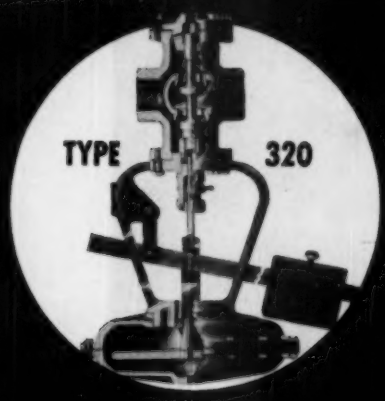
KANSAS CITY • OKLAHOMA CITY • TULSA

Efficiency at a Real Saving

New BS&B Climax WATER REGULATOR

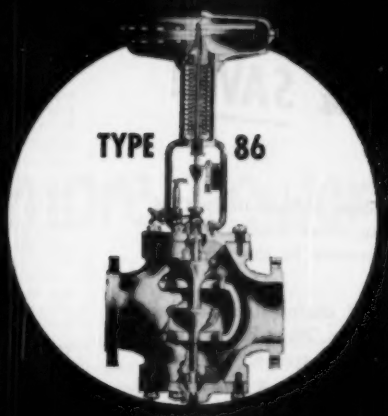
PRESSURE REDUCTION OR BACK PRESSURE REGULATOR

Type 320 Regulators allow sensitive pressure control in vapor vacuum and low pressure steam heating systems. Weight loaded, pressure operated, diaphragm actuated. Built for long life under rugged conditions.



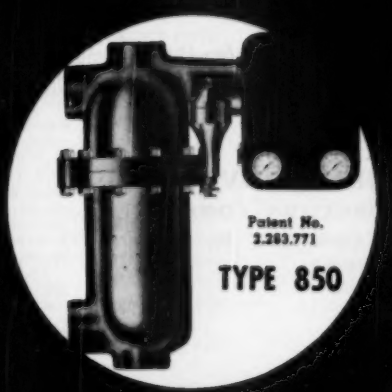
DIAPHRAGM CONTROL VALVE

Type 86...famous the world over for high lift, accurate control, ease of maintenance. Fully reversible in the field. Super polished lower stem for minimum friction. Wide rangeability. Check coupon for catalog.



DISPLACEMENT LIQUID LEVEL CONTROLLERS

No leakage...no stuffing box...no friction problem! That's the Type 850, a BS&B Climax-developed exclusive. Ideal wherever liquid level control involves exacting and wide range control. Shown here with Type 1410 BS&B Climax Control Pilot. Complete catalog available...send coupon now.



The MONTH...

F. Pew, Sun Oil Company, Philadelphia; vice presidents, John F. Lynch, La Gloria Corporation, Corpus Christi; F. M. Perry, Cities Service Oil Company, Bartlesville; T. L. Taggert, Standard Oil Company of California, San Francisco, and Albert H. Weil, United Gas Pipe Line Company, Shreveport.

Supply Men's Slate

L. L. Dresser, Dresser Engineering Company, Tulsa, was elected president of the Natural Gasoline Supply Men's Association for 1950-51. Dresser succeeds J. N. McClure, Elliott Company, Tulsa.

Dallas S. Deem, American Air Filter Company, Inc., Tulsa, was elected first vice president; M. E. Duncan, Johns-Manville Sales Corp., Tulsa, second vice president, and M. A. Ellsworth, The Fluor Corporation, Ltd., Tulsa, treasurer.

Directors elected for a two-year term (1950-52) are as follows: V. V. Jacomini, Hudson Engineering Corporation, Houston; A. F. Canada, Jr., Pacific Pumps, Inc., Tulsa; C. C. Clover, Westcott and Greis, Inc., Tulsa; J. Dvoracek, Black, Sivalls & Bryson, Inc., Tulsa; M. A. Ellsworth; Warner Lewis, Warner Lewis Company, Tulsa; J. A. Mussler, Continental Supply Company, Dallas; M. H. Kotzebue, Gasoline Plant Construction Corporation, Houston, and Ray E. Miller, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del.

Works on Improvements Of the Gaylor Process

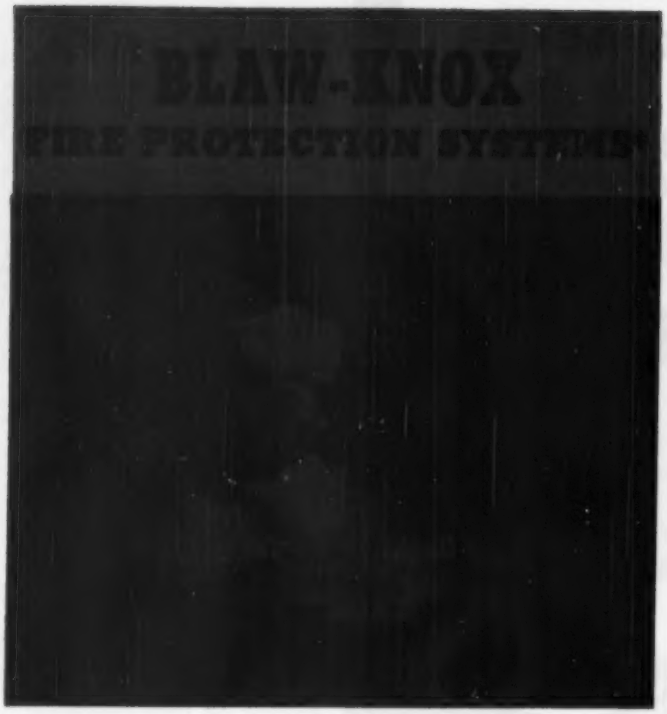
Dr. Chas. W. Rippie, Summit, N. J., vice president and technical director of American Development Corporation, reports work designed to improve the Gaylor process to recover spent treating solutions by electrolytic means. The conventional steam stripping tower, heat exchangers, condensers, and coolers, are replaced by electrical cells which operate at ambient temperatures. The economies are said to offer an attractive payout at a moderate capital investment—on the basis of process maintenance and operation costs and the recovery of chemicals and lead tetraethyl.

Rippie

Stanolind Gas Project Opened at Levelland

William J. Murray, Jr., chairman of the Texas Railroad Commission, was principal speaker at the opening ceremonies of the Levelland gasoline plant, which is operated by Stanolind Oil and Gas Company for 11 participating owners. Lt. Gen. Ernest O. Thompson, Railroad Commission member, was also present, with James E. Pew, manager of the gas division, Sun Oil Company, serving as master of ceremonies.

The plant, located three miles west of Levelland, Texas, has a capacity of 40 million cubic feet and a recovery of 130,000 gallons daily. This includes 60,000 gallons of 12-pound natural gaso-



Not the COST, but what you SAVE!

BY *protecting* oil or volatile liquids storage from fire with a Blaw-Knox Fire Protection System, more than enough is saved on insurance to pay for the system in the first few years. After that, savings continue!

Special hazards in the petroleum and chemical industries demand expert planning of fire protection. Blaw-Knox offers you—without obligation—the services of specially trained fire protection experts and engineers to plan a protection system for you using water spray, fog, or CO_2, according to your needs.

"LITTLE JOEY SPRINKLER"

**Deluge Systems, Wet Pipe Systems, Dry Pipe Systems, Water Spray and Fog Systems, Rate-of-Rise Sprinkler Systems, and Carbon Dioxide Extinguisher Systems.*

BLAW-KNOX SPRINKLER DIVISION
OF BLAW-KNOX CONSTRUCTION COMPANY
829 Beaver Ave., N.S., Pittsburgh 12, Pa.
Offices in Principal Cities

The MONTH...

line, 40,000 gallons of butane, and 30,000 gallons of propane. Residue gas will be sold to El Paso Natural Gas Company.

Plant officials include Mitt Dowlen, superintendent; G. A. Ayling, foreman; R. N. Hall, engineer; and R. A. Sawyer, clerk. (See detailed description of plant, page 139.)

Thomas Bryan Opens New York Branch Office

Thomas Bryan and Associates, Inc., of Houston, engineers and constructors, announce the opening of their New York branch office with Rodman B. Doremus of Greenwich, Conn., as manager. Doremus, who will handle business in the North and East, has been a construction and engineering consultant since his resignation in 1948 as executive vice president of F. H. McGraw & Company.

Doremus

While with McGraw Doremus was directly responsible for over $100 million of construction. He received a citation from the Navy for his performance in engineering and construction work during World War II.

Mississippi to Determine Octane Count by Research

Effective October 1, 1950, octane number in Mississippi will be based on the Research method instead of the Motor method, according to the API News Digest. The measure, recently passed by the state legislature, requires premium gasoline octane count to be 86 and other grades 80 octane. It specifies that premium gasoline be colored red and regular grade colored any color except blue, water, white, red, green, or mahogany and that retail outdoor storage tanks and pipes above ground be color coded.

Also, the gasoline tax increase of from six to seven cents per gallon will take effect this July 1.

Chemical Engineer Heads Whiting Refinery

Dr. M. R. Schmidt, general superintendent of the Whiting refinery, retired early this month, after more than 32 years service with Standard Oil Company (Indiana).

A. F. Endres, assistant general superintendent, succeeds Schmidt. P. C. Livesay, superintendent of the projects division, replaces Endres, and Dr. Ford H. Blunck, assistant superintendent of the light oils division, succeeds Livesay.

Dr. Schmidt joined Standard in 1917 as a member of the Whiting research staff. He has served as head and assistant head of the lubricating department, assistant general superintendent and general superintendent. Schmidt holds A.B. and Ph.D. degrees from Johns Hopkins University.

Endres has been with Standard since 1923 when he began as chemical re-

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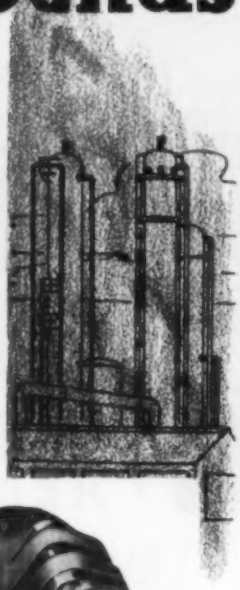

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The MONTH...

search engineer at Whiting. Other positions have been with the manufacturing department as head of the finishing department in the light oils division, crude still department, and pressure still department. He has been superintendent and assistant superintendent of the light oils division and was made assistant general superintendent in 1946.

Livesay and Dr. Blunck joined the company in 1937 and 1936 as engineer and chemist, respectively.

Receives Continental Grant to Cambridge

William F. Brown, general foreman in the lubricating oil division of Continental Oil Company's Ponca City refinery, has been selected as one of 14 to be awarded a 1950-51 Sloan fellowship at the Massachusetts Institute of Technology. Brown, 32, will leave for Cambridge University in June where he will study business administration and economics.

Brown

Brown attended the University of Arkansas and received B. S. and M. S. degrees from Tulsa University in petroleum engineering. He joined Continental as technologist in 1943 and has been general foreman of the lubricating oil division since 1948. He will continue on the payroll while going to school.

NPC OK's Import Study, Refuses Gas, Fuel Oil

The National Petroleum Council has agreed, provided its Agenda Committee approves, to give further consideration to how the imports problem could be handled. This study, requested by Interior Secretary Chapman, would require the NPC group making the study to refrain from proposing any plans or programs for dealing with the situation, this for fear the council might run afoul the antitrust laws.

The council turned thumbs down on Secretary Chapman's request that the NPC undertake a study of synthetic fuel cost figures developed by the Bureau of Mines, to study and report on similar figures developed by the industry sources and to submit recommendations as to the manner in which the Bureau's figures might be improved. Reasons cited for the rejection were: 1) the study would call for an investigation of supplies of and requirements for manufactured gas which is the product of a competing industry upon which the council is not fully informed and the subject matter of which is outside the scope of the council action; and 2) the Agenda Committee agrees with Secretary Chapman that coal, oil, gas, and other energy products are highly substitutable, and therefore they compete with each other.

New Phillips Cat Cracker

Phillips Petroleum Company announced early in May that it will build

The MONTH...

a 30,000-barrel-per-day cat cracker at its Phillips, Texas, refinery. The new unit, to be constructed just south of the present Phillips refinery, promises to be ready for operation in August, 1951.

Oronite Chemical Names President and Chairman

T. G. Hughes has been elected president of Oronite Chemical Company, with his predecessor, George L. Parkhurst, elected chairman of the board. Oronite is the chemical products subsidiary of Standard Oil Company of California.

Hughes

Hughes joined Standard in 1926 and has been with Oronite since its formation in 1943. He has been executive vice president for the last year.

Parkhurst takes the place of R. G. Follis, Standard's board chairman, who remains as a director of Oronite.

Construction Under Way At Antwerp Refinery

With design engineering completed and construction under way, the complete 30,000-barrel-per-day refinery of Societe Industrielle Belge des Petroles at Antwerp, Belgium, heads toward completion in the middle of 1951. Contract for the work is jointly held by The M. W. Kellogg Company and its European subsidiary, Kellogg International Corporation.

The refinery, completely integrated, is located on a site adjacent to the Scheldt River. Extensive development work is being undertaken by the Port of Antwerp Authority to improve facilities for the ships that will bring crude to this refinery. Sufficient space has been provided for the future addition of process units to produce additional products, such as lubricating oil and high octane gasoline.

Tractors Use Almost Half Total Farm Oil Products

Farm consumption of motor fuel by tractors in 1948 is estimated by the Agriculture Department's Bureau of Agricultural Economics at 3.3 billion gallons, representing 40 percent of total farm use of all liquid petroleum products of 8.2 billion gallons. A 45 percent increase in 1949 in the number of tractors since 1945 is expected to bring a substantial increase over 1948 consumption of tractor fuel and consumption. Since 1920, consumption of motor oil per 100 gallons of tractor fuel has declined continuously.

Opens Consultant Office

George F. Russell has opened consulting offices in Houston, 658 M. & M. Building. He will serve as consultant in natural gas process design, cost estimates, plant appraisals, and economics.

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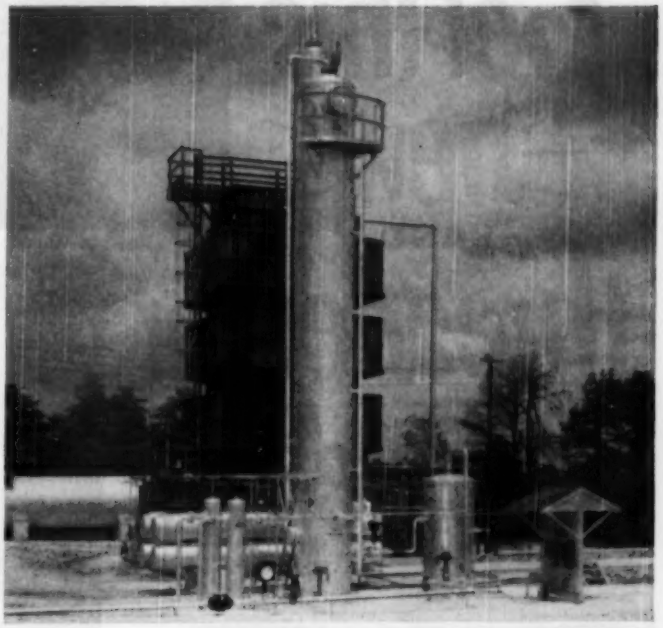

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Digest of Recent U. S. PATENTS Pertaining to PETROLEUM REFINING

Compiled by HEINZ HEINEMANN

(From the Official Gazette, February 14, 21, 28 and March 7, 1950)

REFINING

U.S.P. 2,497,097. Method of Preparing Stabilized Organic Sulphur-Containing Compounds. E. N. Roberts and L. W. Mixon to Standard Oil Company (Indiana.)

The evolution of H_2S from sulphur-containing organic compounds, e.g. from a lubricating oil composition containing a sulphurized oleaginous compound, is inhibited by the incorporation of 0.001-4 percent of a quinone, such as benzoquinone, naphthoquinone, or anthraquinone.

U.S.P. 2,497,159. Separation of Olefins. E. V. Fasce to Standard Oil Development Company.

A mixture of hydrocarbons containing normal pentene and branched pentenes is separated by contacting it with a solution of cuprous salt in an organic nitrogen base at a temperature of —29° to +38° C. and a pressure from atmospheric to 200 psi. gauge. An extract solution containing the normal pentene and a raffinate fraction containing the branched pentenes are formed and separated from another.

U.S.P. 2,497,191. Isobutylene Production. C. T. Steele and E. A. Epps Jr. to Standard Oil Development Company.

An isobutylene fraction containing isomeric butene-1 and butene-2 is contacted with H_2SO_4 of 55-70 percent concentration. The resulting isobutylene-sulphuric acid extract contaminated with physically dissolved and mechanically entrained isomeric butene-1 and butene-2 is stripped with an isobutylene fraction free of butene-1 to remove the said contaminants. The thus purified extract is stripped with steam to recover pure isobutylene.

U.S.P. 2,497,296. Purification of Ethylene. F. S. Chance Jr. to E. I. du Pont de Nemours Company.

Ethylene is freed from an acetylene impurity by passing the impure ethylene at a temperature of 30-150° C. through a dispersion of metallic sodium or sodium amalgam in a liquid hydrocarbon to which has been added a quantity of anthracene sufficient to prevent the formation of foam. The ethylene recovered from the gaseous product is purified by distillation.

U.S.P. 2,497,421. Absorption Process. R. N. Shiras to Shell Development Company.

For absorbing desirable volatile hydrocarbons from a gas mixture containing them, a liquid condensate is first separated from the gas. The uncondensed gas is countercurrently contacted with an adsorption oil of lower volatility than the gas constituents in an absorption zone. The separated condensate is introduced into this zone at a point intermediate to the points of introduction of the gas and the absorption oil so as to flow countercurrently to the gas.

U.S.P. 2,497,588. Method of Refining Oil with a Selective Solvent. J. A. Davies to The Texas Company.

Details are claimed of a method for the solvent separation of feed oil containing at least a small proportion of constituents having true boiling points in the range of the solvent boiling temperature and below. A selective solvent, such as furfural, is employed to form extract and raffinate phases, which are separately subjected to fractional azeotropic distillation.

U.S.P. 2,497,967. Removal of Oxygenated Compounds from Synethetic Naphthas. E. F. Wadley to Standard Oil Development Company.

Oxygenated organic compounds are removed from a hydrocarbon fraction, e.g., from a Fischer-Tropsch synthesis naphtha, by contact with a reagent comprising a mineral base lubricating oil, an alkali metal sulfonate and an alkali metal hydroxide at elevated temperature. The reaction mixture is diluted with an aqueous medium and cooled. An oil phase and a water phase separate from each other. A hydrocarbon fraction freed of oxygenated compounds is recovered from the oil phase.

U.S.P. 2,498,177. De-ethanizing Rich Oil. H. M. Nelly Jr. to Refinery Maintenance Company, Inc.

Details are claimed of a process for removing methane and ethane from a rich absorption oil also containing heavier hydrocarbons. For attaining this purpose while retaining a high percentage of the heavier hydrocarbons in the oil, heat is applied both in a preheating and a reboiling step.

U.S.P. 2,498,201. Deodorizing Refined Petroleum Oils and Waxes. E. C. Daigle to Socony-Vacuum Oil Company, Inc.

For producing moisture-free odorless refined petroleum oils or waxes, the material to be treated is blown in liquid condition with air at a temperature of 170-190° F. for removal of the moisture. A small amount of SO_2-gas is then introduced to remove the rancid odor developed by the air-blowing.

U.S.P. 2,498,204. Purification of Lower Olefins. A. W. Francis to Socony-Vacuum Oil Company, Inc.

A mixture containing at least 75 percent of propylene or at least 40 percent of 1-butene is contacted with solid $AgNO_3$. A liquid complex of the olefin with $AgNO_3$ is formed under conditions of temperature and pressure at which this complex is stable. The complex separated under these conditions is dissociated, and the olefin is recovered.

U.S.P. 2,498,629. Concentrated Sulfuric Acid Processes. C. W. McKinnon to Standard Oil Development Company.

Petroleum is refined by treatment with H_2SO_4 of about 98 percent concentration at temperatures below 0° C. in the presence of 1-2 percent by weight of HF added to the H_2SO_4.

U.S.P. 2,498,630. Stabilization of Organic Compounds. R. B. Thompson to Universal Oil Products Company.

Gasoline is compounded with a minor amount of an oxidation inhibitor prepared by reductive alkylation of p-phenylene diamine with a mixture of ketones of different reactivity, e.g., of methyl-ethyl-ketone and acetone, the more reactive ketone (e.g. acetone) being in smaller proportion than the other.

U.S.P. 2,498,656. Process for Breaking Petroleum Emulsions. M. DeGroote and B. Keiser to Petrolite Corporation, Ltd.

Petroleum emulsions of the water-in-oil type are broken by the action of a demulsifier including a drastically-oxidized, hydrophile, oxyalkylated 2,4,6 C_3 to C_4 hydrocarbon substituted monocyclic phenol-C_1 to C_4 aldehyde resin, in which the ratio of oxyalkylene groups to phenolic nuclei is at least 2:1. The alkylene radicals of the composition may be ethylene, propylene, butylene, hydroxypropylene or hydroxbutylene radicals. A gaseous oxygen-containing medium is employed for effecting the drastic oxidation.

U.S.P. 2,498,657-8. Processes for Breaking Petroleum Emulsions. M. DeGroote and B. Keiser to Petrolite Corporation, Ltd.

A water-in-oil petroleum emulsion is broken by treatment with a demulsifier including a water-miscible oxyethylated ricinoleic acid-polycarboxy acid glycerol

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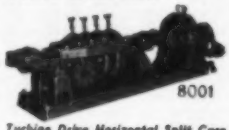
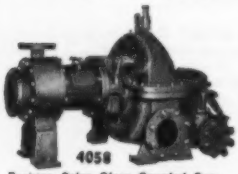


8001

Turbine Drive Horizontal Split Case Multi Stage Centrifugal Pump

4049 A

Two Stage Close Coupled Centrifugal Pump



4058

Turbine Drive Close Coupled Centrifugal Pump

942

Single Style, Packed Piston Pattern Steam Pump

2352 B

Durable Duplex, Outside End Packed, Plunger Pattern Steam Pump

3918

Durable Duplex, Packed Piston Pattern Steam Pump

3833

Horizontal Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump

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Patents

ester. The ricinoleic ester shall be of a particular type described in detail in the claims. According to U.S.P. 2,498,658 a water-miscible oxyethylated triricinoleic acid ester of special type is employed for the same purpose.

U.S.P. 2,498,806. Production of Ethylene. K. H. Hachmuth to Phillips Petroleum Company.

Details are claimed of a process for the recovery of pure ethylene from a mixture comprising free hydrogen, ethylene, propane and lighter paraffins together with not more than minor amounts of heavier hydrocarbons.

U.S.P. 2,498,928. Separation of Cyclopentane-Neohexane Mixtures by Azeotropic Distillation with Methyl Formate. G. C. Ray to Phillips Petroleum Company.

In the separation of cyclopentane from its mixture with neohexane by fractional distillation, methyl formate is added to the mixture in an amount less than the quantity required to form azeotropes with all hydrocarbons present but sufficient to form an azeotrope with all neohexane. A cyclopentane-rich kettle product free from the additive is recovered.

U.S.P. 2,499,365-8. Chemical Manufacture. M. DeGroote and B. Keiser to Petrolite Corporation, Ltd.

Petroleum emulsions of the water-in-oil type are broken by a demulsifier including a hydrophile oxyalkylated synthetic resin of special combination. According to U.S.P. 2,499,367 certain hydrophile oxyalkylated 2, 4, 6 substituted monocyclic phenol C_1- to C_8-aldehyde resins are used for this purpose. According to U.S.P. 2,499,368 these alkehyde resins shall have C_4- to C_{36} hydrocarbons as substituents in the 2, 4, and 6 positions.

U.S.P. 2,499,369. Processes for Breaking Petroleum Emulsions. M. DeGroote and B. Keiser to Petrolite Corporation, Ltd.

The process of this patent is related to those of U.S.P. 2,499,365-8. In the present case the hydrophile synthetic products included in the demulsifier are oxyalkylation products of certain alkylene oxides combined with certain fusible solvent-soluble resinous polymers.

U.S.P. 2,499,370. Process for Breaking Petroleum Emulsions. M. DeGroote and B. Keiser to Petrolite Corporation, Ltd.

The process of this patent is closely related to that of U.S.P. 2,499,368. In the present case the 2,4,6 substituents of the phenol-aldehyde resin shall be C_4- to C_{36}-hydrocarbons.

U.S.P. 2,499,820. Thiourea-Hydrocarbon Complexes and Process for Preparing Same. L. C. Fetterly to Shell Development Company.

Thiourea is contacted with isoparaffins naphthenes, isoolefins, cycloolefins or alkylated aromatic hydrocarbons having at least one isoparaffin radical of at least 6 C atoms in the presence of water and/or an alcohol at a temperature below 75° C. A crystalline complex is formed. This process is particularly useful in separating a mixture of organic compounds con-

taining at least one hydrocarbon of the above named types.

U.S.P. 2,500,122. Emulsions. J. K. Dixon and R. L. Morgan to American Cyanamid Company.

Stable emulsions of mineral oil, paraffin wax, etc., with water are formed by means of 0.1-2.5 percent of a water immiscible emulsifier which is a cationic amido compound of special complicated structure.

CATALYST PREPARATION, ACTIVATION, AND REGENERATION

U.S.P. 2,498,709. Aromatization Catalysts and the Preparation Thereof. R. M. Roberts, F. T. Eggertsen, and B. S. Groensfelder to Shell Development Company.

Activated alumina is impregnated with zinc or copper nitrate or the like in an amount corresponding to 2-12 percent of the metal. The mixture is calcined at a temperature of 500-850° C. The resulting product is impregnated with ammonium molybdate or the like in an amount equivalent to 4-20 percent of molybdenum, which is then converted to molybdenum oxide. The product is useful as an aromatization catalyst.

U.S.P. 2,498,789. Recovery of Hydrogen Fluoride. P. H. Carnell to Phillips Petroleum Company.

Details are claimed of a process for the recovery of HF employed as a catalyst in the alkylation of hydrocarbons, wherein the alkylation effluent is separated into a liquid hydrocarbon-rich phase and a heavier HF-rich phase which if further treated for the recovery of the HF by treating the aqueous HF solution with a liquid cycloolefin and re-decomposing the organic fluoride formed. A process is also claimed for the production of a drying oil by contacting aqueous HF solution with a cycloolefin with 4-7 C atoms in the ring under such conditions that an organic fluoride is formed which is heated after separation to decompose it into a vaporous fraction comprising HF and a liquid fraction comprising hydrocarbons.

U.S.P. 2,499,255. Catalyst Preparation. R. L. Parker Jr. to Union Oil Company of California.

Hydrocarbons are heated to 700-1200° F. in the presence of a catalyst comprising a major proportion of a carrier and a minor proportion of a molybdenum oxide-containing catalytic agent. The catalyst is prepared by mixing powders of the catalytic agent and carrier in the desired proportions, forming pellets from the mixture, and heating the pellets to a temperature of 10[illegible]700° F. for a time sufficient to sublime the molybdenum oxide and adsorb the sublimed vapors on the carrier. This catalyst is useful in hydrocarbon conversions, such as hydroforming, dehydrogenation, desulfurization, etc.

U.S.P. 2,499,675. Preparation of Pelleted Alumina Catalyst. J. R. Owen to Phillips Petroleum Company.

Hydrated alumina or bauxite containing at least 28 percent of combined water is calcined at a temperature of 470-

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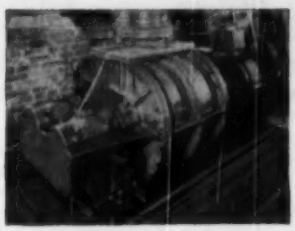

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490° C. under conditions such that the product when ignited to constant weight at about 2200° C. undergoes a weight loss of 20-26 percent. The resulting material is compressed into pellets, and the pellets are calcined to remove the residual water of hydration.

U.S.P. 2,499,680. Preparation of Spheroidal Desiccant. C. J. Plant to Socony-Vacuum Oil Company, Inc.

Details are claimed of a process for preparing spheroidal gel desiccant pellets from a hydrosol of a water-insoluble inorganic oxide with a pH value of 5-10, predominating in silica.

U.S.P. 2,500,056. Method and Apparatus for Solvent-Cleaning Finely Divided Solids. F. T. Barr to Standard Oil Development Company.

In removing deposits from finely-divided solids, particularly in the reactivation of powdered hydrocarbon synthesis catalysts, a dense turbulent mass of the solids carrying the deposits is fluidized by a gas. The surface of a rotary filter is rotated through this mass while maintaining a higher pressure outside this filter than inside so as to deposit finely-divided solids on this surface as a filter cake. A solvent for the deposited impurities of the solids is applied to this filter cake on the circular path at a point outside the turbulent mass. This solvent is forced by the existent differential pressure through the filter cake whereby the deposited impurities are dissolved and removed.

POLYMERIZATION AND CONVERSION

U.S.P. 2,497,106. Apparatus for Pyrolytic Conversion of Hydrocarbons. K. M. Watson to Sinclair Refining Company.

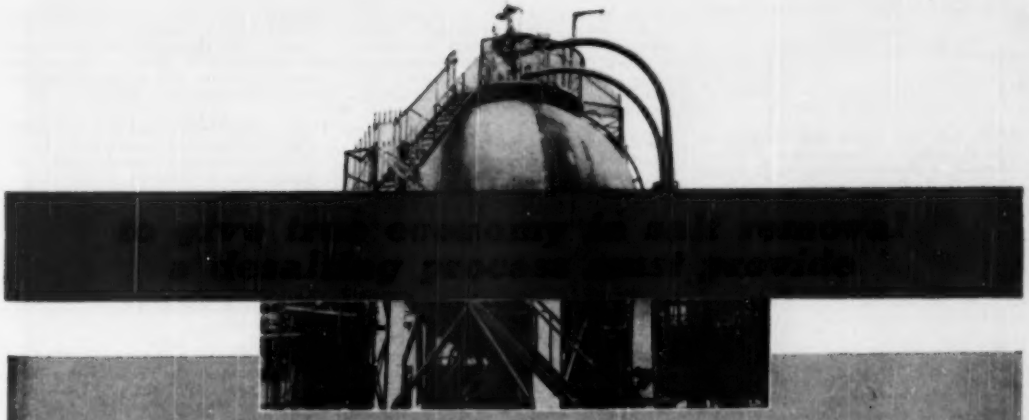
Details are claimed of an apparatus for the pyrolytic conversion of hydrocarbons in the presence of a solid catalyst. The catalyst is partly regenerated in the lower zone of the vertically elongated body of catalyst and the partially regenerated catalyst body is then suspended in a stream of additional air flowing upwardly through a second vertically elongated chamber. Catalyst fines are removed with the flue gases.

U.S.P. 2,497,107. Process of Polymerizing Conjugated Dienes in the Presence of Selected Alkyl Esters of Mercaptyl Undecanoic Acids as Polymerization Regulators. K. H. Weber to Armstrong Cork Company.

An open chain, aliphatic conjugated diene with 4-6C atoms or a mixture of such a diene with a vinyl compound is emulsion polymerized in the presence of alkyl 10 or 11-mercaptyl undecanoate or a mixture thereof, wherein the alkyl radical has 1-4C atoms. These additives work as polymerization regulators.

U.S.P. 2,497,323. Polymerization of Ethylene. M. J. Roedel to E. I. du Pont de Nemours & Company.

Ethylene is polymerized by heating at a temperature of 70-250° C and under a pressure above 25 atms. in the presence of 0.005-2.0 percent of tert. alkyl percarboxylate of the formula R-O-O-CO-R' wherein R is a tert. alkyl group



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One refiner states that Petreco Desalting "paid out" in *three months!* Another cited a *five months* payout. Payouts such as these represent substantial savings for any refiner charging salty crudes. The reasons most frequently cited for Petreco's fast payout are: Less plugging in crude furnaces, heat exchangers and reduced crude furnaces; less corrosion in topping units. *You get FAST PAY-OUT with PETRECO.*

OPERATIONAL FACTS...

If you have a desalting problem, ask Petreco for facts and figures—Petreco engineers can tell you why Petreco desalters deliver such high removal percentages, how Petreco Service is designed to help you, and why, how and where Petreco Desalters have more than paid their own way. *Get facts! They're available from*

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SPECIALIZED *Electric* PETROLEUM PROCESSES { DESALTING / DEHYDRATING

PR 50-2

Patents

and R' is an aryl hydrocarbon radical with not more than 20 C atoms.

U.S.P. 2,497,447. Silica Sol Catalyst in the Emulsion Polymerization of Butadiene-1, 3 Hydrocarbons. A. J. Green to U. S. Rubber Company.

An emulsion of a butadiene-1, 3 hydrocarbon alone or in mixture with a compound containing a single $CH_2=C<$ group, such as styrene, is polymerized at a pH from 2 to below 7 in the presence of 0.2-2 parts dry weight of hydrous silica sol per 100 parts of polymerizable material as a catalyst.

U.S.P. 2,497,833. Process for Polymerizing Butadiene or the Like in the Presence of Tetra-Aryl Succino Di-Nitrile and Products Thereof. D. Josefowitz to Publicker Industries, Inc.

Five parts of butadiene-1, 3 are heated with 0.03-0.10 parts of tetraaryl succino di-nitrile at about 120° C for 24-48 hours. A fairly hard rubbery non-sticky and transparent product is formed.

U.S.P. 2,497,940. Conversion Process. C. E. Hemminger to Standard Oil Development Company.

Details are claimed of a process for the catalytic conversion of hydrocarbon oils wherein the vaporized oil is passed upwardly through a conversion zone into which a stream of finely divided catalyst is continuously passed and the velocity of the oil vapors is limited to maintain a dense layer of catalyst in the bottom portion of the conversion zone superimposed by a dilute phase of reaction products containing entrained catalyst. The new process requires less recovery equipment and less volatile material is passed to the regenerator.

U.S.P. 2,498,088. Conversion of Hydrocarbons with Suspended Catalysts. W. K. Lewis and E. R. Gilliland to Standard Oil Development Company.

Details are claimed of a process for the conversion of hydrocarbons in vapor-phase in the presence of finely divided catalyst maintained in a liquid-like, turbulent suspension in the vapor by controlling the rate of introduction of catalyst into the reaction zone. The vapor under treatment thus shall have a catalyst concentration of upwards of 3 percent by volume. A corresponding concentration shall also be maintained during the regeneration of the catalyst in fluidized state.

U.S.P. 2,498,607. Conversion of Hydrocarbons. E. T. Layng to The Polymerization Process Corporation.

Olefin hydrocarbons are passed at elevated temperature through a consolidated granular mass consisting of an intimate mixture of catalyst granules and spacer granules which are in physical non-adhering contact with the catalyst granules. The latter comprise an intimate mixture of phosphoric acid and supporting material, while the spacer granules are composed of charcoal and sufficiently coarse to preserve the desired permeability for the catalyst mass.

U.S.P. 2,498,999. Manufacture of Isobutylene. W. C. Offutt to Gulf Research Development Company.

Details are claimed of a process for depolymerizing a liquid isobutylene dimer by means of a synthetic surface-active silica-alumina catalyst.

U.S.P. 2,499,304. Method and Apparatus for Hydrocarbon Conversion. L. P. Evans to Socony-Vacuum Oil Company, Inc.

Details are claimed of a method and an apparatus for the conversion, e.g. the cracking of high boiling liquid hydrocarbons to valuable lower boiling products by means of a particle-form solid contact material. A substantially uniform conversion temperature is maintained throughout the length of the conversion zone.

U.S.P. 2,499,305. Apparatus for Gaseous Conversions in the Presence of a Moving Contact Material. F. C. Fahnestock to Socony-Vacuum Oil Company, Inc.

The construction of a reaction vessel is claimed for the conversion of gaseous material in the presence of a compact column of particle-form contact material. The construction makes possible suitable distribution of gaseous reactants into and collecting of gaseous reactants from the moving column of contact material without interference with the steady and uniform movement of this material.

U.S.P. 2,499,796. Polystyrene Resin and Polymerization Process. J. D. Surmatis to Chemical Development Corporation.

Monomeric styrene is heated at 37-110° C. for 3-24 hours in the presence of H_2SO_4, H_3PO_4, or a similar catalyst and certain restrainers, such as acetic acid present in a defined proportion to the acid catalyst. A solid, light-colored rubbery polymer is obtained.

CRACKING AND REFORMING

U.S.P. 2,498,444. Production of Acetylene. J. B. Orr Jr., Great Barrington, Mass.

Details are claimed of a process for endothermically producing unsaturated aliphatic hydrocarbons such as acetylene and ethylene, from gases containing saturated hydrocarbons of the methane series, e.g. natural gas. The methane is cracked by contact with a stream of combustion gases having a temperature of 1500-2000° C.

U.S.P. 2,498,840. Catalytic Cracking of Diisobutylene. F. B. Johnson to Standard Oil Development Company.

Higher boiling hydrocarbons to be cracked are passed upwardly through a mass of dense-phase, dry, fluidized catalyst particles in the lower portion of the reaction zone and through a dilute phase thereof in its upper portion. A normally liquid isobutylene polymer is injected into the reactor at a level not below the dense-phase dilute phase interface, in order to subject this polymer to milder cracking conditions than the higher boiling feed stock and to transform it mainly to isobutylene.

U.S.P. 2,498,883. Process for Hydrocarbon Conversion. H. O. Folkins to The Pure Oil Company.

Hydrocarbon oil is cracked in the

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the great uniformity of hole size—the wide range of commercial "mesh" sizes (25 to 400)—the valuable ductility and the tensile strength of 50,000 to 100,000 psi—and the fact that it can be stamped, cut, drawn and even scraped without distortion of its mesh, all make

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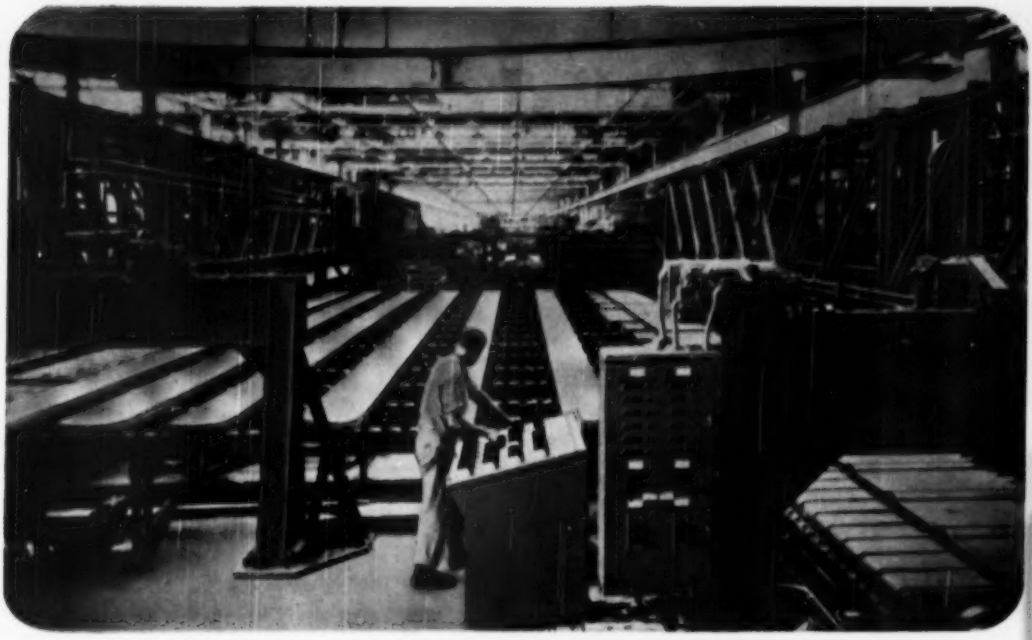
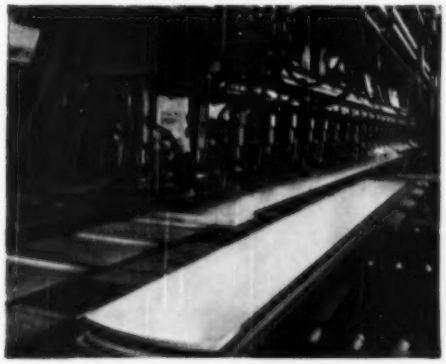


TO BUILD OR NOT TO BUILD



The smaller illustration is of the vacuum cup handling equipment operating in conjunction with the 2-Hi Cold Rolling Mill. Because of the massive size and weight of individual brass bars, all handling is mechanical.

This Mill, designed and constructed by Stone & Webster Engineering Corporation, is capable of producing the heaviest non-welded coils of strip brass, and includes the largest cold breaking-down mill in America.

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Why do the men on the firing line in a tough job of still tube cleaning, almost invariably demand Lagonda where they have any choice? It is because the Lagonda has the power and stamina to tear through the job quickly, to make a mean task easier, to complete its assignment without failure or undue trouble.

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TUBE CLEANERS

Y-203

presence of bromocyclohexane in an amount equivalent to 0.001-0.1 percent by weight of bromine based on the oil as the sole catalyst. Gasoline is obtained.

U.S.P. 2,499,435. Control of Corrosive conditions in Condensers of a Fixed Bed Catalytic Cracking Unit. C. H. Whitacre to The Standard Oil Co. of Ohio.

In the catalytic cracking of hydrocarbons, at least a portion of the vapors produced is condensed which include steam and are excessively corrosive to the condensing apparatus. The condensate water is separated from the condensed hydrocarbons and collected, and the vapors produced are contacted with 1-10 parts of this condensate water to one part of steam condensed from the reaction products. It is the object of this process to inhibit corrosion of the condenser unit by minimizing the pH fluctuations.

U.S.P. 2,499,704. Process for Heating Granular Solids. E. Utterback and E. V. Bergstrom to Socony-Vacuum Oil Company, Inc.

Details are claimed of a process for heating by direct contact with a flame a mass of granular heat transfer material to be used, for example, in combination with a material for the production of light gaseous olefins by cracking of heavier hydrocarbons at high temperature and short reaction time.

ALKYLATION

U.S.P. 2,498,567. Process for Producing Ethylbenzene. H. E. Morris and D. M. Evans to Monsanto Chemical Company.

An olefin, such as ethylene, and benzene are combined in the presence of an aromatic hydrocarbon catalyst complex composed in part of $AlCl_3$. This complex is separated from the mixture of monoalkylbenzene and a tar-containing polyalkylbenzene fraction and then contacted with this latter fraction. Tar is thus removed from this fraction and combined in the complex. The tar-containing catalyst complex is then separated from the polyalkylbenzene fraction. The latter is thereafter de-alkylated in the presence of catalyst complex resulting from the first named separation. High yields of monoalkylbenzenes are obtained.

U.S.P. 2,499,488. Synthetic Process for Manufacturing Oily Products. A. Gislon to Compagnie Francaise de Raffinage (Soc. Anon.).

Details are claimed of a process for continuously producing an oily product by treating a liquid phase aromatic hydrocarbon with a liquid phase complex reactant comprising the reaction product of an alkyl halide and an $AlCl_3$-catalyst in an elongated vertical reaction-fractionation zone.

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,497,176. Hydrogenation Catalyst. R. B. Mason to Standard Oil Development Company.

High molecule weight hydrocarbons containing sulphur are contacted under non-destructive hydrogenation conditions with a catalyst consisting of 40-90 percent of nickel sulfide promoted with a minor amount of thoria (0.5-15 percent of the catalyst), the balance being substantially alumina. The feed oil is hydrogenated to saturated hydrocarbons without substantial depolymerization or cracking.

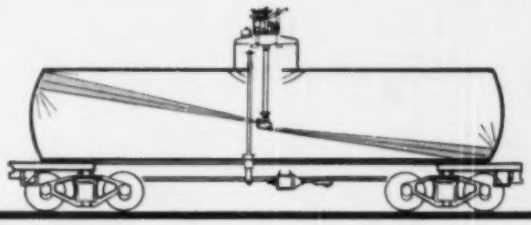
U.S.P. 2,497,761. Synthesis of Hydrocarbons. A. Clark to Phillips Petroleum Company.

In a Fischer-Tropsch synthesis for the production of liquid hydrocarbons, a predominately olefinic fraction boiling between 25 and 200° C. is separated from the reaction effluent and recycled to the reaction zone. The yield of liquid hydrocarbons is increased.

Patents

U.S.P. 2,498,838. Synthesis of Hydrocarbons. L. I. Griffin to Standard Oil Development Company.

A CO/H_2 mixture is passed under synthesis conditions in contact with a dense turbulent fluidized catalyst forming a well defined upper level which separates the catalyst mass from an upper and low density catalyst zone. Heat is withdrawn from this mass by indirect heat exchange. A major portion of the product gases withdrawn from the catalyst is recycled at the temperature of withdrawal directly to the cata-



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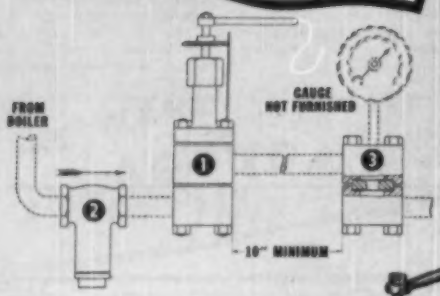

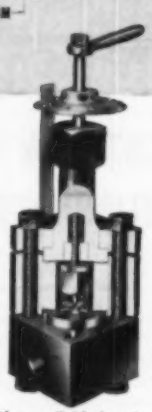

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Patents

lyst. A minor portion of these gases is passed through a product recovery system. After removal of reaction products therein, tail gases from this system are recycled to the catalyst. The total recycled gas shall be 1.5-20 times the volume of fresh feed gas but sufficient to maintain the catalyst in a highly turbulent state.

U.S.P. 2,497,932. Hydrocarbon Synthesis Operation. J. C. Dart to Standard Oil Development Company.

Carbon oxides and hydrogen are contacted with an iron catalyst under synthesis conditions to obtain formation of hydrocarbons higher than methane. Overhead reactant gases are cooled to condense water and hydrocarbons. At least a portion of the uncondensed gases is treated with a solvent to remove the oxygenated hydrocarbons formed, such as polyethylene glycol. The solvent treated gases are then recycled to the reaction zone.

U.S.P. 2,497,964. Synthesis of Hydrocarbons. S. D. Summerford to Standard Oil Development Company.

In the interaction of CO and H_2 in the presence of a fluidized iron type catalyst at a temperature of 500-700° F. and a pressure of 400-600 psi., an oxygen content of 5-30 percent by weight is maintained in the catalyst by injecting into the reactor an amount of steam ranging from 0.05-0.8 part by volume of steam per part of hydrogen in the total feed. The formation of carbon is greatly reduced.

U.S.P. 2,498,845. Hydrocarbon Synthesis Reaction. L. B. Smith and R. W. Krebs to Standard Oil Development Company.

In the synthesis of hydrocarbons, a finely divided fluidized iron-type catalyst is first treated with hydrogen and then with methane gas in the absence of carbon oxide. Thereafter, the catalyst is contacted with synthesis gases and methane with gradually increasing amounts of H_2 and carbon oxides under synthesizing conditions until the synthesis gases represent 100 percent of the fresh feed. The temperature of the synthesis reaction is thus controlled immediately after the revivification of the catalyst.

U.S.P. 2,499,372. Manufacture of Hydrocarbons. E. L. d'Ouville to Koppers Company, Inc.

A synthesis gas composed of 40-60 percent CO and 50-30 percent H_2 with minor amounts of impurities, or a synthesis gas obtained by reacting methane with CO_2 of residue gas obtained in the process, and moisture, is passed at superatmospheric pressure into contact with a sintered iron catalyst at a temperature of 250-350° C. Substantially only liquid hydrocarbons are produced. The synthesis gas is produced by reacting CO_2 of the residue gas of the synthesis process with methane and separately reacting another part of this CO_2 with coke and blending the two gaseous reaction effluents.

DESULFURIZATION

U.S.P. 2,497,954. Method for Removing Emulsifying Agents from Amine So-

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(a patented alloy)

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Here is added evidence of the remarkably low maintenance costs of Nicholson expansion steam traps. In the 2 years Bradshaw & Co. have been distributing them in the Pittsburgh area they have installed 444 traps. But they have received not one order for repair parts. And examination of traps in continuous drainage service for at least 18 months, at steam pressures to 250 lbs., showed no sign of valve cutting.

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CATALOG 448 or see Sweet's

W. H. NICHOLSON & CO., 207 Oregon St., Wilkes-Barre, Pa.

Patents

lution. J. H. McCulley to Standard Oil Development Company.

Acid-containing hydrocarbon gas is contacted with an aqueous solution of ethanol amine mixed with a small amount of an aromatic hydrocarbon boiling between 175-600° F. The hydrocarbon gas freed from acid (e.g. H_2S) is recovered. The manner of regenerating the treating solution is also claimed.

U.S.P. 2,498,559. Desulfurization and Conversion of a Naphtha. E. T. Layng and L. C. Rubin to The M. W. Kellogg Company.

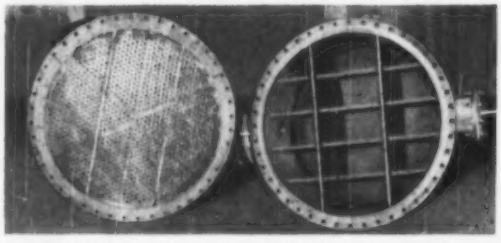
Details are claimed of a process for the conversion of a high sulfur content naphtha to a motor fuel of increased aromatic content and anti-knock quality and free from sulfur in any form. The charge material is treated under special conditions with added hydrogen in the presence of a molybdenum oxide contact.

HEAVY OILS AND WAXES

U.S.P. 2,497,067. Mineral Oil Composition Containing a Thenylamine. H. D. Hartough and S. J. Inkasiewicz to Socony-Vacuum Oil Company, Inc.

Mineral lubricating oil contains a minor proportion of 2-thenyl amine or di(2-thenyl)amine to reduce corrosion.

U.S.P. 2,497,099. Addition Agents for Mineral Oil Lubricants and Compositions Containing the Same. H. G.



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Its resistance to pitting and other forms of corrosion is outstanding. The notable service records it has established in salt water service amply justify its use in other fields where corrosive and erosive effects of water and steam are encountered.

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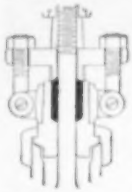
Investigate Teflon-Chemiseal gaskets and packing. They can save you hundreds of dollars and countless production delays.



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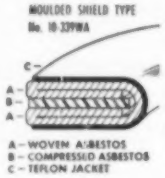

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Camden, New Jersey

Patents

Smith, T. L. Cantrell and J. G. Peters to Gulf Oil Corporation.

A mineral lubricating oil contains a minor amount of a neutral polyvalent metal salt of a bis(2-hydroxy, 3-paradimethylaminobenzyl, 5-tetramethylbutyl, phenyl) methane, to confer detergent properties on the composition.

U.S.P. 2,497,132. Lubricating Oil Composition. L. A. Mikeska to Standard Oil Development Company.

A mineral lubricating oil contains as an oxidation inhibitor a minor amount of a complicated organic thiophosphorous acid compound, described in detail, or an alkaline earth salt thereof.

U.S.P. 2,497,432. Antirusting Composition. E. S. Blake to Monsanto Chemical Company.

A refined mineral oil fraction contains a small amount of oil soluble olefinic alcohol esters of mono-ethylene glycol bis alkylene dicarboxylic acid ester. The olefinic alcohol contains 18-22 C atoms and the dicarboxylic acid contains 4 C atoms. The additive imparts antirusting properties to the oil which is useful as a lubricant and turbine oil.

U.S.P. 2,497,521. Oil Compositions Containing Amine Salts of Boro-Diol Complexes. C. E. Trautman to Gulf Research & Development Company.

A hydrocarbon oil contains a small amount of an amine salt of an acid compound of boric acid and a glycol or a polyhydroxy benzene. The oil composition has improved stability characteristics, such as improved resistance to sludge formation and improved anti-corrosion properties.

U.S.P. 2,498,961. Mineral Oil Composition. E. A. Oberright to Socony-Vacuum Oil Company, Inc.

A mineral oil contains a minor proportion of paraffin wax-hydroxy-carboxy-benzyl morpholine or a polyvalent salt thereof, the morpholine group being attached by its secondary nitrogen atom to the CH_2 group of the benzyl radical.

U.S.P. 2,499,710. Anticorrosive Lubricating Oil and a Process of Fractionating Alkali and Alkaline Earth Metal Petroleum Sulfonates. C. E. Wilson to Union Oil Company of California.

An anticorrosive lubricating oil with high resistance to humidity consists of a lubricating oil and an alkali or alkaline earth metal soap of petroleum sulfonic acids which are obtained by a process claimed in detail.

U.S.P. 2,498,863. Lubricating Oil Composition. D. E. Badertscher, C. F. Feasley and H. G. Berger to Socony-Vacuum Oil Company, Inc.

A viscous hydrocarbon fraction is compounded with a minor amount of a product of the general formula: R^1-A-R^2-B-R^3 where R^1 and R^3 are tert. lower alkyl groups, R^2 is a divalent lower alkyl group and A and B are trithiocarbonate groups. The oil composition has improved oxidation resistance.

U.S.P. 2,498,628. Lubricants and Extreme Pressure Additives Therefor. E. B. Cyphers and L. J. Osborne, Jr., to

SIDE ENTERING MIXER FOR OILMEN

Eastern side entering agitators are specially engineered for large tank installations. Material tending to settle during mixing is kept in motion by the propeller; bottom precipitation is thus prevented. Cast ribbed bases supporting motor and stuffing box insure rigid alignment — eliminate wear and leakage.

These heavy duty mixers are available with pressure stuffing box, twin rotary seal or mechanical rotary seal; also with outboard stuffing box which can be repacked without emptying tank. They're powered with motors rated from ¼ to 30 H.P., with rotating speeds from 400 to 1725 R.P.M.

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Zallea Expansion Joint News

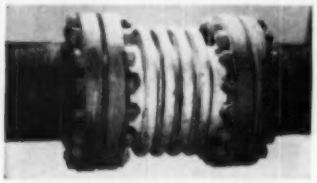
PUBLISHED BY ZALLEA BROTHERS—WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS EXCLUSIVELY

Expansion Joint of the Month

Why Zallea Joints Last Longer

WHEN THE "HEAT'S ON"

Over six years ago a large oil refinery installed 39 non-equalizing expansion joints in its reactor piping. Within six months these joints failed . . . unable to withstand the terrific punishment of 1125° F. vapor temperatures. These were replaced by Zallea Expansion Joints. Today, over 5½ years later, these Zallea Expansion Joints, one of which is shown here in an unretouched photo, are giving trouble-free performance. Actually, both joints look alike . . . same alloy steel, same physical appearance.



But that's where similarity ends. The difference lies in the *control* exercised in every step of the manufacturing process of Zallea Expansion Joints. It's that *control* that makes Zallea the ideal joint for absorbing contraction and expansion of pipe lines due to temperature changes. Be *sure* of trouble-free operation in *your* plant . . . always specify ZALLEA.

. . . a complete, practical catalog on all Zallea Expansion Joints. A text book and a valuable reference source. Send for your *free* copy *today!*

ZALLEA BROTHERS, 890 Locust Street
Wilmington 99, Delaware

CONTROLLED WELDING ASSURES LONGER EXPANSION JOINT LIFE

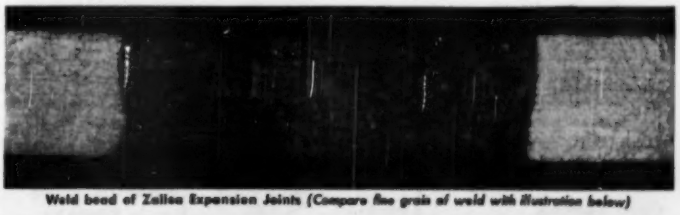
In a corrugated expansion joint, the deflection stress varies directly as the bellows thickness. And, the life of a corrugated expansion joint varies as the cube of the bellows thickness. Therefore it is essential that the corrugated bellows have a uniform thickness throughout. Only in Zallea Stainless Steel Expansion Joints are you assured of this optimum condition because Zallea alone produces a longitudinal weld of the same thickness as the parent metal.

Welding Methods Tested

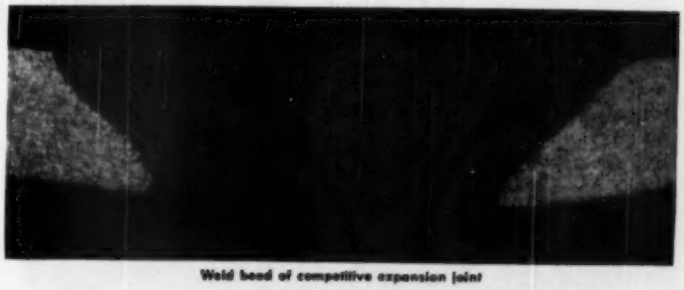
Accelerated flexing tests of corrugated bellows proved that the resultant welding bead of a shielded arc weld was detrimental to the life of the bellows because failure always occurred across the weld —thickest section of the bellows. Zallea metallurgists, after analyzing the many known welding processes, found that by adopting an exclusive variation of the Heliarc process and adding a grain refining procedure to the finished weld, they could produce a corrugated bellows that under accelerated flexing tests *failed in the parent metal only.*

Longer Life Assured

In over 100 bellows tested with Zallea *controlled* welding, not one failure occurred within 30 degrees of the weld line. More important was the fact that these bellows lasted four to eight times longer than bellows having a shielded arc welding bead. The two unretouched photomacrographs below illustrate the exclusive Zallea *controlled* welding technique as compared to the welding procedure used in other expansion joints. When you want the best in stainless steel expansion joints, always specify ZALLEA . . .you'll find it pays!



Weld bead of Zallea Expansion Joints (Compare fine grain of weld with illustration below)



Weld bead of competitive expansion joint

Patents

Standard Oil Development Company.

An extreme pressure lubricant comprises 80-99 percent of petroleum lubricating oil and 1-20 percent of an additive which consists of specific amounts of a sulfurized and phosphorized fatty material and of tricresyl phosphite or phosphate. The first named treated fatty material is prepared by first heating certain amounts of sulfur with the fatty material until the reaction is completed, and then heating the resulting sulfurized material with a small amount of P_2S_5.

PETROCHEMICALS

U.S.P. 2,497,303. Reaction between Olefinic Compounds, Carbon Monoxide, and Hydrogen in the Presence of a Metal Carbonyl Catalyst. W. F. Gresham and R. E. Brooks to E. I. du Pont de Nemours & Company.

An olefin, such as ethylene, is reacted with CO and H_2 in the presence of cobalt carbonyl catalyst. This catalyst is introduced into the reaction mixture at a temperature of 75-250° C. and a pressure of 50-300 atms. Oxygen-containing reaction products particularly aldehydes are formed. Thermal decomposition of the catalyst is suppressed by said pressure.

U.S.P. 2,497,304. Preparation of Carboxylic Acid Anhydrides. W. F. Gresham and R. E. Brooks to E. I. du Pont de Nemours & Company.

An olefin with 2-4 C atoms and of the formula $RR_1C=CR_2R_3$ wherein R, R_1R_2 and R_3 each represent hydrogen or an alkyl radical is heated with CO and an aliphatic carboxylic acid of the formula R_4COOH, wherein R_4 is an alkyl radical at a temperature of 200-500° C. and superatmospheric pressure in the presence of a nikel carbonyl catalyst. A carboxylic acid anhydride is formed of the formula $RR_1CHR_2R_3COOCOR_4$.

U.S.P. 2,497,310. Synthesis of Amines. A. T. Larson to E. I. du Pont de Nemours & Company.

A mixture of CO, H_2, NH_3 or an amine with at least one hydrogen attached to the nitrogen, a hydrocarbon with an olefinic unsaturation and a cobalt metal catalyst is heated at a temperature of 50-350° C. under a pressure above 50 atms. Amines are produced, such as di-n-propylamine from ethylene and ammonia.

U.S.P. 2,497,349. Production of Alicyclic Alcohols. A. Farkas and A. I. Smith to Union Oil Company of California.

A saturated cyclic hydrocarbon with 4-8 C atoms is oxidized in the liquid phase with a gas containing free oxygen. The resulting product containing the hydroperoxide of the cyclic hydrocarbon is reduced to form an alicyclic alcohol of the same carbon skeleton.

U.S.P. 2,497,408. Manufacture of Propylene Glycol Esters. W. F. Gresham to E. I. du Pont de Nemours & Company.

A mixture of propylene and acetic acid is reacted with an oxidizing gas at a temperature of 100-350° C. under a pressure of at least 400 psi. in the presence of a mixed catalyst of an alkaline earth acetate and a lead or ferric acetate. Propylene glycol mono- and di-acetate are formed.

U.S.P. 2,497,959. Alcohol Process. R. F. Robey and S. G. Gallo to Standard Oil Development Company.

An isomeric mono-olefinic hydrocarbon mixture containing predominantly normal olefins and tertiary base olefins in a ratio of normal olefins to tert. base olefins of 2.5-10:1 is treated for absorption with a strong acid extract of at least unit saturation prepared by absorbing the equivalent of at least one mol of isomerous normal mono-olefin per mol of acid. No substantial polymerization of the tert. base olefins is effected.

U.S.P. 2,498,546. Manufacture of Halogenated Hydrocarbons. E. Gorin to Socony-Vacuum Oil Company, Inc.

Paraffinic hydrocarbons, such as methane, are treated with HCl in the presence of cupric oxychloride at a temperature of 325-500° C. The rate of introduction of the cupric oxychloride is regulated so that at least one mol thereof is introduced per mol of HCl introduced into the reaction zone. Chlorinated hydrocarbons are recovered from the gaseous reaction effluent.

U.S.P. 2,498,552. Halogenation Process. E. W. Kilgren and E. Gorin to Socony-Vacuum Oil Company, Inc.

The process according to this patent

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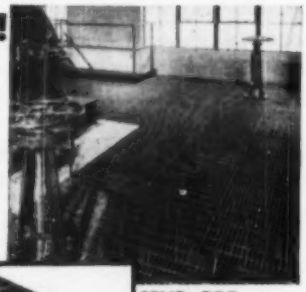

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Du Pont Research { Functions In Two Ways

Research on Fuel Performance in Engines Available Today

The final measure of any fuel's performance is its behavior under actual driving conditions. That is why Du Pont maintains two road test fleets. One, a passenger car fleet, is located in the East; the other, made up of heavy duty trucks, is based at El Monte, California. To relate the findings from these operations with future developments, Du Pont also operates cars with experimental high compression engines, some of which utilize compression ratios as high as twelve to one.

Basic Long Range Research on Fuels of the Future

Just as engine design and characteristics change to give better performance, fuels likewise must be changed to meet new demands. To anticipate these changes, Du Pont is studying the basic nature of combustion, both from a physical and a chemical standpoint. The work is directed not only toward improvement of present antiknock compounds and other additives, but also toward the development of new compounds which will help refiners meet the higher performance standards of the future.

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BETTER THINGS FOR BETTER LIVING
. . . Through Chemistry

USE DU PONT TETRAETHYL LEAD COMPOUNDS

Du Pont Research Reports are Available on Request

An Up-To-Date Informative Program . . .

The results of Du Pont research on fuels, fuel utilization, and fuel blending problems are available to all refiners. Some of these findings are in the form of published papers. Other information which may apply directly to problems that confront you can be obtained from Du Pont Sales or Technical Representatives.

Organized Attack on Industry-Wide Problems . . .

Many problems, such as sulfur-tetraethyl lead interaction in motor fuels, are common throughout the industry. Du Pont is aware of such problems and has launched a concerted attack upon them through all phases of research. In many instances this involves physical and chemical studies of fuels and combustion processes.

Facilities to Work on Your Problems . . .

The center of Du Pont Petroleum Chemicals Research is located at Deepwater, N. J. Here extensive facilities exist for research on problems involving fuels, their components, or their use in internal combustion engines. In addition to these studies, requirements for the future are constantly being explored in the Company's Wilmington Experimental Station, for which a new $30,000,000 expansion project is nearing completion.

Material on TEL and Additives

. . . A number of papers recording the results of Du Pont Research on various problems have already been published. Among these, the following may be obtained through your Du Pont Representative or the nearest Du Pont District Office:

- **Sulfur-Tetraethyl Lead Interaction in Motor Fuels** —*By* H. K. LIVINGSTON
- **Effect of Sulfur on Combustion of Leaded Gasoline** —*By* H. K. LIVINGSTON, J. L. HYDE, M. H. CAMPELL
- **Inhibition of Deterioration of Cracked Gasoline During Storage**—*By* C. J. PEDERSEN
- **The Effect of Sulfur Compounds on Octane Number of Leaded Fuels**—

  Part I—Comparison of Different Sulfur Compounds

  Part II—Sulfur Antagonism in Different Fuels

  By H. K. LIVINGSTON

DID YOU KNOW

. . . that Du Pont makes many products used in the automotive field? These include the famous No. "7" line of radiator cleansers, sealers, and inhibitors, No. "7" Polish and "Duco" Wax, "Zerone" and "Zerex" anti-freeze solutions, and many others.

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District Offices: Wilmington, Del. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · Los Angeles, Calif.

A-507

differs from that of U.S.P. 2,498,546 substantially only in that instead of HCl free Cl_2 is employed.

U.S.P. 2,498,616. Polymerization Products of Styrene. W. S. Emerson to Monsanto Chemical Company.

A mixture of styrene and certain unsaturated nitriles, such as benzal malonitrile or ethyl alphacyanocinnamate, wherein the latter may be present to 1-50 percent by weight, is copolymerized. A resinous product is obtained.

U.S.P. 2,498,872. Mercaptan Synthesis. R. T. Bell and C. M. Thacker to The Pure Oil Company.

A mixture of olefinic hydrocarbons and H_2S is contacted with a Friedel-Crafts catalyst under suitable conditions to promote the formation of mercaptans. Details of a special embodiment of this process are claimed.

U.S.P. 2,499,055. Production of Nitriles. J. N. Cosby and M. Erchak, Jr., to Allied Chemical & Dye Corporation.

A gaseous mixture containing oxygen, ammonia and an alkyl or alkenyl substituted benzene or naphthalene hydrocarbon is contacted at temperatures of 350-600° C. with a catalyst useful in the vapor phase partial oxidation of benzene and naphthalene to maleic and phthalic anhydride. Aromatic nitriles are produced. The gaseous mixture shall contain at least 1 mol. ammonia for every CN radical in the resulting nitrile.

U.S.P. 2,499,120. Production of Hexachlorocyclohexane. D. E. Stormon to Hooker Electrochemical Company.

Hexachlorocyclohexane with a high content of the gamma isomer and substantially free of chlorinated substitution products is obtained from a mixture of liquid benzene and gaseous chlorine under the influence of actinic radiation by a process claimed in detail.

U.S.P. 2,499,505. Vinylcyclohexene Hydrochlorides. H. L. Johnson and A. P. Stuart to Sun Oil Company.

1-vinylcyclohexene-3 is contacted under vigorous agitation with about 12 normal aqueous HCl-solution at a temperature of 55-75° C. The volume ratio of the HCl-solution to the hydrocarbon shall be maintained at about 0.6 to 1.8. The monohydrochloride of 1-vinylcyclohexene-3 is obtained.

U.S.P. 2,499,515. Oxidation of Aromatic Hydrocarbons. A. P. Lien to Standard Oil Company (Indiana.)

An oxygen-containing gas is passed into a liquid mixture of a low boiling aromatic hydrocarbon and $HF\text{-}BF_3$ catalyst under such conditions that addition complexes of HF, BF_3 and hydrocarbon oxidation products are formed. These complexes are separated from unreacted hydrocarbon and subjected to a temperature and pressure to decompose them and liberate $HF\text{-}BF_3$ catalyst and hydrocarbon oxidation products, respectively. Phenol and xylenols can, for example, be produced by this process.

U.S.P. 2,499,578. Method of Chlorinating Hydrocarbon Mixtures. L. H. Flett to Allied Chemical & Dye Corporation.

A petroleum distillate boiling over a

Solving the Refinery
WASTE DISPOSAL PROBLEM
. . . automatically, economically!

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Trap residues—separator box emulsions—sludges . . . the Oliver Precoat Filter can effectively handle these wastes by dewatering sludges and breaking oil-water emulsions, resulting in stocks for refinery re-run and water ready for disposal in public streams. For example, a refinery is obtaining an oil phase carrying only 2/10 of 1% sludge and only a trace of water; the water phase is comparatively oil-free.

Oliver United engineers, calling on their 42 years of filtration experience and their many varieties of filter types, developed this closed type, continuous vacuum precoat filter for handling refinery wastes. It's proving a boon to refineries in connection with this vexing problem.

A letter or phone call to our nearest office will have a skilled refinery filtration engineer at your plant whenever desired to make a study and recommendations for a filtration plant to handle the wastes properly.

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Another very profitable use of the Oliver Precoat Filter in refineries is in connection with contact clay handling. Many are in service providing continuous handling, great reduction in oil losses over other methods, and more easily handled cake.

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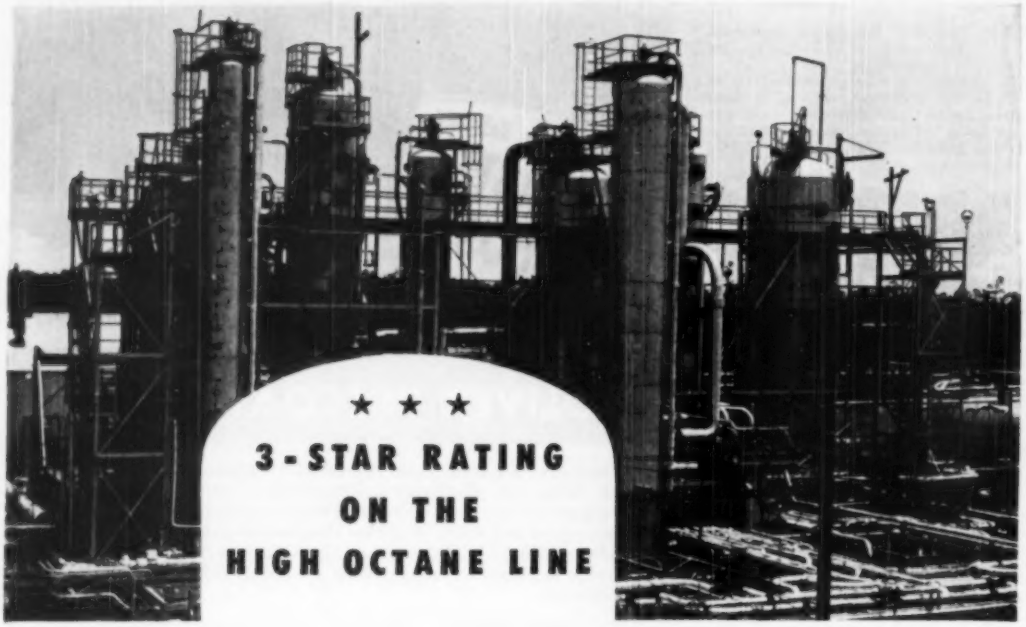

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ENDURO Stainless Steel, on duty in the "hot spots" along the refinery line, comes out of the ordeal with a 3-star from oil men everywhere. ★ Star number one—for its stubborn, unyielding resistance to blistering heat (or with equal strength—subzero cold). ★★ Star number two—for its equally creditable stamina under both constant and variable high pressure, that less valiant metals cannot take. ★★★ Star number three—for its great resistance to corrosion and to rust, to destructive gases and fumes.

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temperature range of 80° C. at atm. pressure and 350° C. at 22 mm absolute pressure is chlorinated by introducing chlorine gas in an amount not exceeding that effective to chlorinate this distillate to a degree corresponding to 15 percent chlorination. Additional chlorine is introduced into a flowing stream of the resulting partially chlorinated distillate while maintaining the temperature of the reaction mixture within the range of 60-175° C. The total amount of chlorine relative to the start material shall be at least sufficient to obtain a product chlorinated to 75 percent. The resulting product has a low aniline point.

Esso Labs Develop New Agricultural Fungicide

A new agricultural fungicide, developed by the Esso Laboratories of Standard Oil Development Company, is a synthetic organic material containing as the active component, the compound "N-trichloromethylthio-tetrahydrophthalimide." This chemical is a colorless, crystalline compound melting at 172° C, insoluble in water, but soluble in some organic solvents. Designated by the code name SR-406, the fungicide is to be manufactured and distributed in the U. S. by California Spray-Chemical Corporation of Richmond, Calif., and Elizabeth, N. J., under a licensing arrangement.

The material, which shows activity against vegetable blights and high potency on fruits, appears to be non-toxic to warm-blooded animals, based on preliminary toxicological testing. It is expected to be brought before the current residue tolerance hearings of the Food and Drug Administration in Washington relative to the government's approval for use in agriculture.

West Texas Oil Analyses

Six Scurry County oil sample analyses, including oils from the Canyon Reef limestone, Strawn limestone, and Ellenberger limestone formations are given in an appended table which includes analyses of 51 crudes from 39 fields. All of the analyses were made by the Bureau of Mines routine crude oil analysis method. Other data on the samples include producing formation and age, the depth in feet, °API Gravity, Color, Sulfur percent, viscosity at 100° F. sec. and carbon residue percent. Previously published analyses of crude oil samples from West Texas are included in Bureau report of investigations 4289, "Analyses of Crude Oils from 283 Important Oil Fields in the United States," by C. M. McKinney and O. C. Blade, and in report of investigations 3744, "Analyses of Crude Oils from Some West Texas Fields," by Boyd Guthrie.

For copies write Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13.

Journalist Retires

Rounding out nearly 42 years of journalism, Paul Truesdell has retired from Universal Oil Products Company, Chicago, as a member of the advertising and public relations staff. He has been with the firm for more than 20 years.

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HORSE POWER RANGE
600 LB. GA., 750° F.
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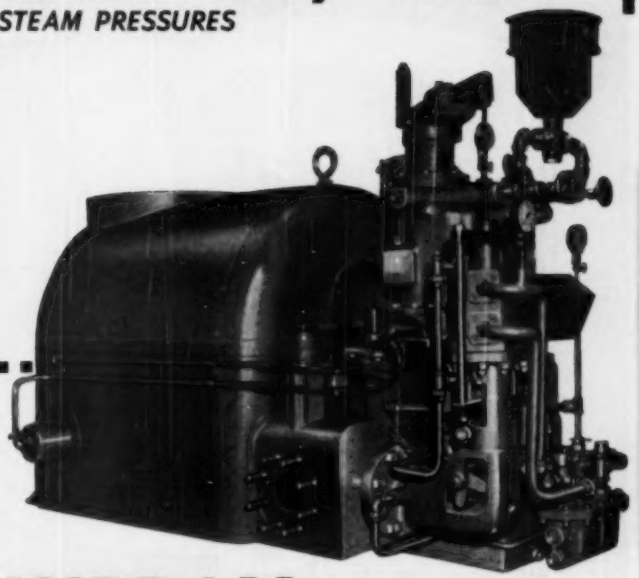

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STEAM TURBINES
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The Type UV Multistage Turbine is available in from two to ten pressure stages making Multistage steam economy available at moderate initial cost. Horsepower range is from 100 to 4000, steam pressures up to 600# ga., 750° F., condensing or non-condensing. Several governors and accessories adapt UV Turbines to practically any mechanical drive within the capacity range.

Pictured is a 5 Stage UV Turbine developing 325 HP at 6200 RPM operating condensing. Turbine is equipped with variable speed oil relay governor, pressure lubrication and vacuum breaker, and is in use driving a centrifugal compressor for refrigeration.

Contact your Murray representative for prices and engineering information or write for Bulletin T-122.

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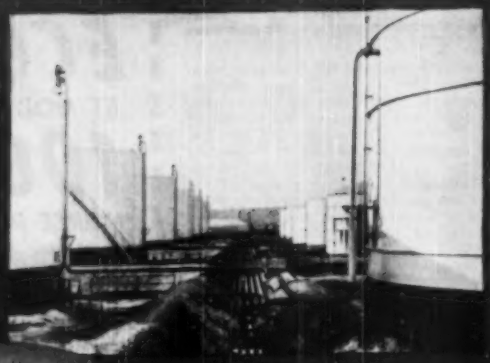

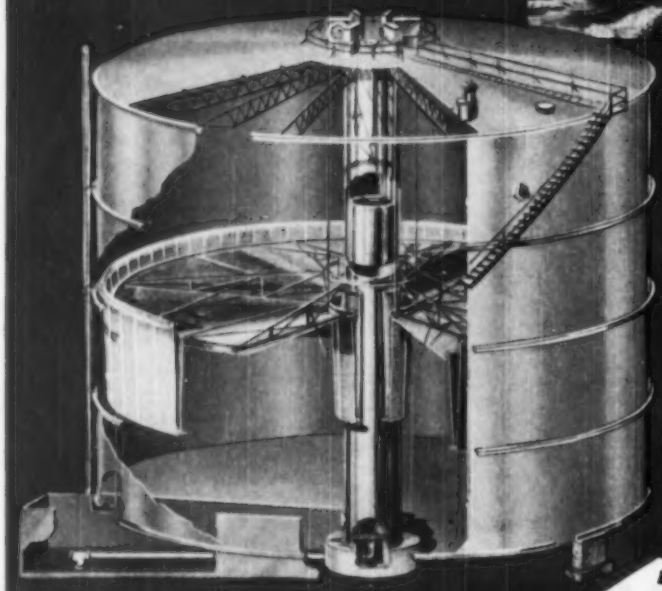

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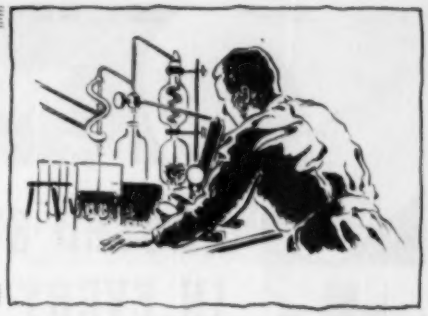
SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.



Products: Properties, Utilization and Analysis

Antiknock Effect of Aromatic Compounds. The Effect of Aromatic Compounds on the Vapor-Phase Oxidation of Fuels. Part 2. The Antiknock Effect of Aromatic Compounds in Engines. A. D. WALSH. *Trans. Faraday Soc.*, **55** (1949), pp. 1043-8.

A study was made of the effect of aromatic compounds on the behavior of fuels in internal combustion engines, with particular reference to knocking, which concluded that the anti-knock effect of compounds is an effect of undissociated molecules, their anti-knock effect increases with decreasing strength of binding of the electrons in the benzene ring. Deviations from this latter are caused by decomposition or oxidative destruction under the conditions used, and are therefore more likely to occur at high temperature. These conclusions afford a working knowledge of the anti-knock action of aromatics, and provide a method for predicting whether untried aromatic compounds will be effective. No aromatic compound with a long side-chain is likely to be effective because the side-chain will be readily split off. Bonds attaching the side-chain to the ring must not be weak. The side-chain must not be such as to cause a great spread of the electronic cloud of the ring. For use near the temperature limit of the additive's thermal stability, the compound will be more effective if all conditions are such as to give the coolest operation possible.

Bitumen Horizons. A. W. JARMAN. *Jour. Inst. of Petroleum*, **36** (1950), pp. 2-24.

The author reviews the current British practice in the utilization of bitumen, including its use for road and airfield surfacing, for hydraulic engineering, and for many industrial purposes. Combined with this, the author expresses views on those features of bitumen which at present limit its scope in the hope that these would provide a basis for discussion and stimulate further inquiry into the possibility of modifying the properties of bitumen and thus extending its already diverse field of utilization. The author takes opportunity to consider some of the minor obscurities that attach to the subject and upon which discussion may lead to clarification.

Microdetermination of Knock Characteristics of Motor Fuels. JULIAN ALEXANDER JR. AND CARL PFEIFFER. *Analytical Chem.*, **22** (1950), pp. 476-80.

The 300-cc. sample normally used for determination of knock characteristics has placed a considerable strain on the laboratory and pilot plant equipment used to prepare experimental samples of gasoline. The authors describe a method by which motor and research octane numbers can be determined on 20-cc. samples of fuel with an accuracy approaching that of the standard test procedures. The customary knock engine is used, but there are two alterations in design and one change in procedure, namely, the amount of waste fuel in the fuel inlet system is reduced from 60 to 1 cc. by the use of a specially designed glass capillary inlet system. The running time necessary for the standard knock meter to reach equilibrium is eliminated by replacing it with an instantaneous knock meter recorder. The running time required for the adjustment of the compression ratio and the fuel-air ratio is reduced by the use of several shortcuts including a continuously variable fuel-air ratio. The standard deviation in 42 runs on different fuels was 1.42, and that for 38 motor octane determination was 1.15.

Stability of Fuel Oil/Gas Oil Blends. D. G. BUTLIN. *Jour. Inst. of Petroleum*, **36** (1950), pp. 43-55.

A method is given for the selection of asphaltic fuel-oil and gas-oil components of blends that will be stable in storage. The procedure is particularly applicable to the preparation of low-viscosity diesel-fuel blends where a high degree of dilution of fuel with gas oil is necessary. The compatibility of the components is measured by means of an index assigned to each oil, namely, the xylene equivalent of the fuel and the aniline point of the gas oil. In order to substantiate the use of these indices for the purpose a laboratory method was developed in line with practical conditions, so that actual sludge deposition can be related to the varying indices of the components used in such blends. Excellent correlation has been obtained on a large number of blends, prepared from components of widely different nature and origin, and it is believed that the validity of the principles underlying the method is established. A blending stability curve was constructed that permits the ready interpretation of the relative characteristics of any particular pair of blending components.

Bromination Methods of Measuring Unsaturation in Motor Spirit—A Critical Survey. G. F. WILSON. *Jour. Inst. of Petroleum*, **36** (1950), pp. 25-42.

The methods employed to measure the degree of unsaturation in hydrocarbon oils are historically reviewed. The author then discusses the use of reagents introduced by Kaufmann which comprises a solution of bromine in pure methanol, saturated with sodium bromide. The use of this reagent was experimentally investigated. The influence of peroxides on the value of bromine numbers is discussed and a method is given for the determination of the bromination correction. The mechanism of the bromination reactions by Kaufmann's reagent is considered. Although the addition reaction is recognized as characteristic of unsaturated hydrocarbon, the investigation has proved that the double bond is anything but an automatic trap for unwary halogen, but is rather an objective to be gained only by subtle and devious attacks by the halogen. A bibliography of 41 references is given.

Estimating Oil Yield of Oil Shale from Its Specific Gravity. I. C. FROST AND K. E. STANFIELD. *Analytical Chem.*, **22** (1950), pp. 491-2.

The specific gravity of oil shale can be used as a criterion of oil yields from shales derived from a given source. The study of 39 shales indicates that there is a definite characteristic relationship between specific gravity and oil yield. A curve is given showing the relationship of the specific gravity to oil yield of Colorado oil shale. Data are given for 38 other foreign and domestic oil shales.

These abstracts from the current literature of science and technology (not including trade journals easily available) were prepared by Drs. Leslie and Coats of The Leslie Laboratories, Traver Road, Ann Arbor, Mich., which will supply, at cost, photostatic copies of original articles. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, also may be had by arrangement with the Laboratories.

Manufacture: Processes and Plant

Heat and Mass Transfer in Fluidized Systems. K. N. KETTENRING, E. L. MANDERFIELD, AND J. M. SMITH. *Chem. Eng. Progress*, **46** (1950), pp. 139-45.

One of the characteristics of fluidized reactors is the uniformity of temperature in the direction of gas flow. For this to be true, a high heat transfer rate

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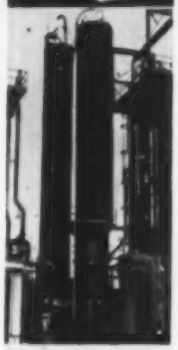

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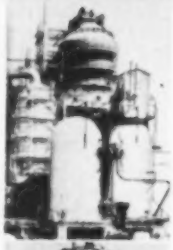

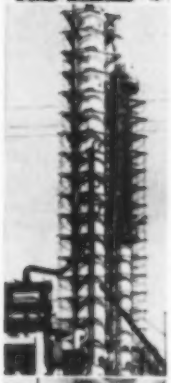

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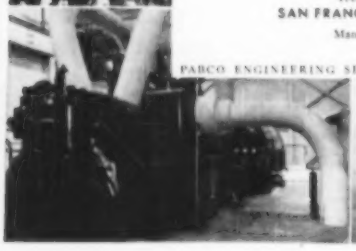

between catalyst particles and gas is necessary. The authors measured the rates of heat and mass transfer between the solid particles and the gas stream for silica gel and activated alumina fluidized in air. Data were obtained in a vacuum-jacketed glass tube 2.3 inches in diameter, and for particle-size ranges of 14-20, 20-28, 28-35 and 35-48 mesh were studied. The mass velocity of air was varied from 300 to 750 pounds per hour (square foot.) Variations in void space and particle density were insufficient to establish completely the influence of these variables. However, incomplete data indicate a small increase in the coefficients with increase in particle density. Equations are given that correlate the experimental results.

Determination of Mechanism of Catalyzed Gaseous Reactions. K. H. YAND AND O. A. HOUGEN. *Chem. Eng. Progress*, **46** (1950), pp. 146-57.

The authors state that the paper is written as a guide in the planning of experimental programs in applied kinetics and as an aid to the selection of the mechanisms of catalytic reactions. Methods are given for eliminating, minimizing and evaluating the temperature and the concentration gradients in gas films and in catalyst pellets. A procedure is given for rating the rate equations for various postulated mechanisms of four simple molecular reactions. Selection of the reaction mechanism from the effects of pressure, feed composition, extent of conversion and temperature is given. After the mechanism of a reaction has been established, various constants in the appropriate rate equations can be obtained from the experimental data by graphical and statistical methods. A reference to the proper procedure is given. The authors explain the limitations of their suggested approach and state that it represents a compromise between methods that are so involved in theory as to be beyond the experience and training of the usual process engineer, and methods which are so empirical as to be unsafe for extrapolation beyond the range of experimentation

Heat Transfer. WILLIAM H. MCADAMS. *Chem. Eng. Progress*, **46** (1950), pp. 121-130.

The author presented the First Institute Lecture at the Pittsburgh meeting of the American Institute of Chemical Engineers. This first annual review of unit operations is a panoramic view of Heat Transfer, and covers the fundamentals of several types of heat transfer, summarizes recent developments, and outlines the need for further work. Thermal conduction and thermal radiation are first considered, followed by heating or cooling without change of the phase of the fluid. Heat Transfer with change in phase is then discussed, including boiling and condensation. A bibliography of 101 references is included.

Thermal Activation of Attapulgus Clay. Effect on Physical and Adsorptive Properties. W. S. W. MCCARTER, K. A. KRIEGER, AND H. HEINEMANN. *Ind. Eng. Chem.*, **42** (1950), pp. 529-33.

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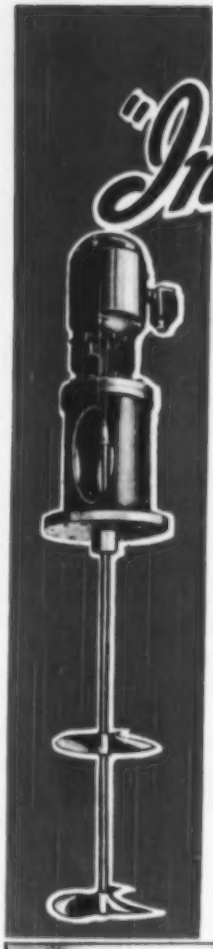

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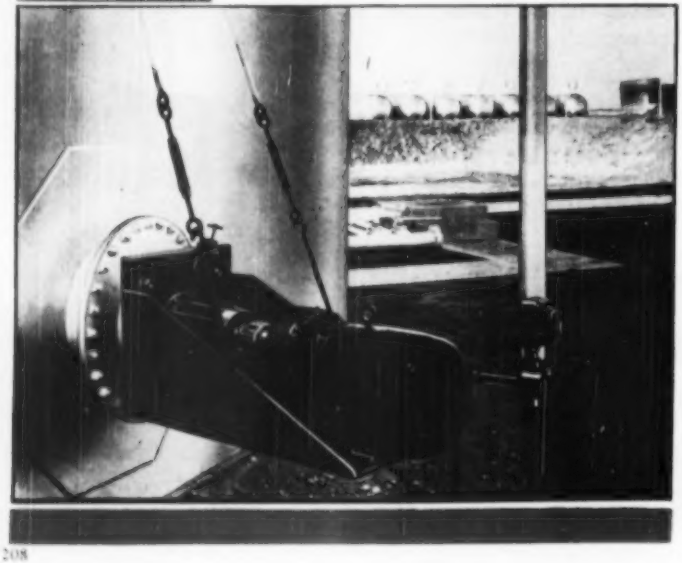

pulgus clay or Fuller's Earth from Attapulgus, Ga. are numerous. It is used in decolorizing, deodorizing, dehydrating, and neutralizing vegetable and mineral oils and waxes. The main component of Attapulgus clay is a hydrous magnesium aluminum silicate that is believed to be a distinct clay mineral. It has been the purpose of the authors studies, part of which are reported in the present paper, to investigate the physical properties of Attapulgus clay in general, and their relation to the activation temperature in particular, to enhance the understanding of its adsorptive action and to give data on its surface and structural characteristics as related to a relatively simple phenomenon, such as drying. In the present article, data are presented on the chemical composition, structure, x-ray diffraction patterns, thermal cleavage, surface area, true, apparent and bulk densities, water adsorptive properties, void volume, pore volume, and equivalent pore diameter for both natural and extruded samples of Attapulgus clay as a function of activation temperature over the range 220° to 1400° F. Water adsorptive properties are correlated with changes in structure during activation. The effect of thermal cleavage upon surface area and water adsorption is considered. The role of extrusion in maintenance of surface area at high activation temperatures is discussed. A bibliography of 48 references is given.

Novel Separation Process Unlocking Canada's Oil Sands. W. E. ADKINS. *Chem. Eng.*, **57** (1950), pp. 102-5.

The oil sands of Alberta constitute the largest single reserve of petroleum in the world as a source of liquid fuel. The mining of the sand and the capital outlay for processing are less than for oil shale or coal. The author describes the mining of the sand, separation process, and the dehydration and the refining of the oil. It is estimated that the sands contain 500 billion gallons of oil in an area roughly 80 miles by 60 miles and approximately 200 feet thick. Saturation varies from as low as 3 or 4 percent to as high as 16 percent by weight. The present plant is an experimental plant having an approximate capacity of 350 barrels per day. The sand ranges from 50 to 200 mesh, and the oil is largely in the form of thin films surrounding the sand grains. The processes used in separating and refining the oil are briefly described.

Wax and Lube Oils Shine at Cit-Con. JAMES A. LEE. *Chem. Eng.*, **57** (1950), pp. 94-6.

The author describes the new Cit-Con lube oil plant near Lake Charles, La. Furfural units are the largest ever constructed. The same is true of the Duo-Sol units. Capacity of the plant is 9700 barrels per day. Water cooling is done on a tremendous scale at the rate of 51,000 gpm. from 117 to 92° F. Cit-Con's products will include 6000 barrels per day of lubricating-oil base stocks and 70 million pounds per year of fully refined crystalline wax. The raw material is a topped crude from a blend of sweet crudes from Texas, Louisiana and Arkansas. The process involves vacuum distillation to produce closely fraction-

ated distillate cuts and a bottom residuum stock, furfural solvent refining of the distilled fractions, Duo-Sol solvent refining of the residuum stock to produce bright stock, MEK solvent dewaxing of each solvent refined fraction including simultaneous recrystallization of crystalline waxes to remove oil and soft wax, and clay contacting of the dewaxed oil to improve color and stability. The de-oiled crystalline wax is acid treated and percolated through bauxite to improve color and odor. Some details of these several processes are given.

Fundamental Physical and Chemical Data

Heats and Combustion and Formation of Cyclopropane. JOHN W. KNOWLTON AND FREDRICK D. ROSSINI. *J. Research Natl. Bur. Standards*, **43** (1950), pp. 113-15.

The heat of combustion of cyclopropane at 25° C. to form gaseous CO_2 and liquid H_2O is -499.85 ± 0.13 kcal./mole. The heat of formation from solid graphite and gaseous hydrogen is calculated at 25° as $+12.74 \pm 0.14$ kcal./mole. The heat of isomerization to propylene as a gas is -7.86 ± 0.18 kcal./mole at 25° C. The freezing point of cyclopropane in air at 1 atmosphere is -127.53 ± 0.01 deg.; and the calculated amount of impurity is 0.0034 ± 0.0012 mole fraction.

Properties of 60 API-NBS Hydrocarbons. Vapor Pressures and Boiling Points of 60 API-NBS Hydrocarbons. A. F. FORZIATI, W. R. NORRIS, AND F. D. ROSSINI. *J. Research Natl. Bur. Standards*, **43** (1949), pp. 555-63.

Vapor pressures and boiling points of 60 hydrocarbons including 17 paraffins, 14 alkylcyclopentanes, 8 alkylcyclohexanes, and 21 alkylbenzenes were measured over the range 48 to 780 millimeters of mercury and above about 11° C. The apparatus used in the work is described. The hydrocarbons were samples from the API-NBS series of highly purified hydrocarbons. The data were correlated, using the method of least squares, with the three-constant Antoine equation for vapor pressure. Values of the constants in the Antoine equation are given in tabular form.

Phase Equilibria in Hydrocarbon Systems. Volumetric and Phase Behavior of the Methane-Propane System. H. H. REAMER, B. H. SAGE, AND W. N. LACEY. *Ind. Eng. Chem.*, **42** (1950), pp. 534-9.

Measurements of the molal volume of four mixtures of propane and methane were made at pressures up to 10,000 pounds per square inch and at temperatures from 40 to 460° F. The composition of the co-existing phases was determined over the range of the two-phase region at temperatures above 40° F. The results as given in the present article supplement earlier measurements on this binary system that were made over a smaller range of pressure and temperature. The results of the former and the present measurements are compared. The data are presented in detail in tabular and graphical form and a bibliography of 15 references is included.

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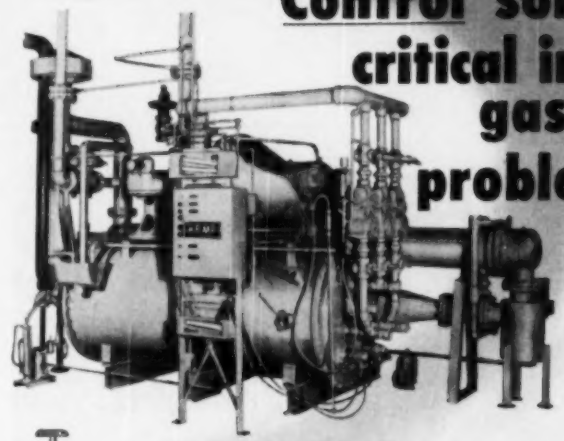

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Science and Technology

Propane-Benzene System. J. W. Glanville, B. H. Sage, and W. N. Lacey. *Ind. Eng. Chem.*, **42** (1950), pp. 508-13.

Volumetric behavior of propane and of benzene have been investigated and reported in considerable detail. However, no phase equilibrium or volumetric data concerning the behavior of mixtures of propane and benzene have been available in the range of conditions of industrial interest. The authors determined the specific volume of mixtures of propane and benzene at pressures from 100 to 10,000 psia. at seven temperatures between 40 and 460° F. The composition of the dew-point gas was measured at five temperatures between 10 and 460° F. for pressures between the vapor pressure of benzene and the critical pressure of the system. Results are given in detail in tabular form and are accompanied by a number of illustrative diagrams. A bibliography of 8 references is included.

Volumetric Behavior of Gaseous Isobutane. The Compressibility of, and an Equation of State for Gaseous Isobutane. J. A. Beattie, S. Marple Jr., and D. G. Edwards. *J. Chem. Phys.*, **19** (1950), pp. 127-8.

The Volumetric behavior of isobutane in the region above the critical temperature was investigated, and the measurements are reported in tabular form. The constants of the Beattie-Bridgeman equation of state for gaseous isobutane are $R = 0.0826$, $A_o = 16.6037$, $a = 0.11171$, $B_o = 0.23540$, $b = 0.07697$, $c = 300 \times 10^4$. Units are normal atmospheres, liters per mole, degrees Kelvin.

Mass Spectra of C_4H_8 Isomers. F. L. Mohler, E. G. Bloom, L. Williamson, C. E. Wise, and E. J. Wells. *J. Research Natl. Bur. Standards*, **43** (1949), pp. 533-6.

Mass spectra of 10 C_4H_8 isomers, are described. Spectra were obtained on a 180° Consolidated mass spectrometer using automatic electron current control and automatic temperature control of the ionization chamber at 245° C. The samples used were 99 percent pure or better and included spiropentane, methylenecyclobutane, cyclopentene, six of the dienes, and 1-pentyne. The mass spectrum of each of these compounds is distinctive. The ratio of total ionization to that of n-butane covers a small range of values from 0.96 to 1.09.

Diffusion Coefficients in Multicomponent Gas Mixtures. D. F. Fairbanks and C. R. Wilke. *Ind. Eng. Chem.*, **42** (1950), pp. 471-5.

A study was made of the diffusion of vapors into multicomponent gases by vaporization of liquids in a long tube under conditions such that the theory of diffusion in the semi-infinite column is applicable. An equation is given which is verified by the results. The apparatus and procedure are described. The gases used were hydrogen, argon, and air and the liquids, toluene, and ethyl propionate. A bibliography of 10 references is given.

Solubility of Water in Hydrocarbons. J. H. Hildebrand. *J. Chem. Phys.*, **17** (1949), pp. 1346-7.

A method of predicting the solubility of water in any hydrocarbon was studied, and a method for analyzing and correlating solubilities was devised. An equation that combined the heat of mixing and the entropy of mixing was used. Results of the work are presented in tabular form. Values are given of the so-called "solubility parameter," which is the square root of the energy of vaporization per cc. This is close to 24.0 for all but the olefins and for these it approximates 22.5. The solubility of water in hydrocarbons can be calculated with a fair degree of approximation.

Chemical Composition and Reactions

The Thermal Polymerization of Monoölefinic Compounds. Willet F. Whitmore and J. Fred Gerecht. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 790-3.

The authors propose an allylic free radical theory to explain the thermal transformations of simple unsaturated compounds, and some experimental support for this mechanism was obtained from a study of two terminally unsaturated compounds, methyl undecylenate and 1-octene.

Formation of Cyclopentadiene from 1,3-Pentadiene. R. M. Kennedy and S. J. Hetzel. *Ind. Eng. Chem.*, **42** (1950), pp. 547-52.

The conjugated double bond structure of cyclopentadiene and its active methylene group make it an attractive monomer for the formation of various polymers, resins, and other derivatives. Nowhere in the literature is there any evidence that cyclopentadiene can be made directly from a non-cyclic compound of

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five carbon atoms. The present work was undertaken to determine whether cyclopentadiene could be synthesized from a noncyclic petroleum material and preferably from n-pentane by dehydrogenation. It was found that 1,3-pentadiene undergoes dehydrocyclization to 1,3-cyclopentadiene. Concurrent side reactions are cracking and polymerization. By operation at low pressures, in the region of 10 to 30 mm. of mercury, side reactions are substantially reduced in extent. This permits ultimate yields of cyclopentadiene approaching 50 percent at 600° to 620° C. and at a contact time of approximately 0.1 second. The apparatus and procedure are described, the results are presented in tabular and graphical form in considerable detail. It is concluded that it is possible to use n-pentane, a plentiful and readily separable component of petroleum, as a raw material for the production of 1,3-cyclopentadiene. A bibliography of 13 references is given.

The Rearrangement of Chlorofluorocarbons by Aluminum Chloride. William T. Miller Jr., Edward W. Fager, and Paul H. Griswald. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 705-7.

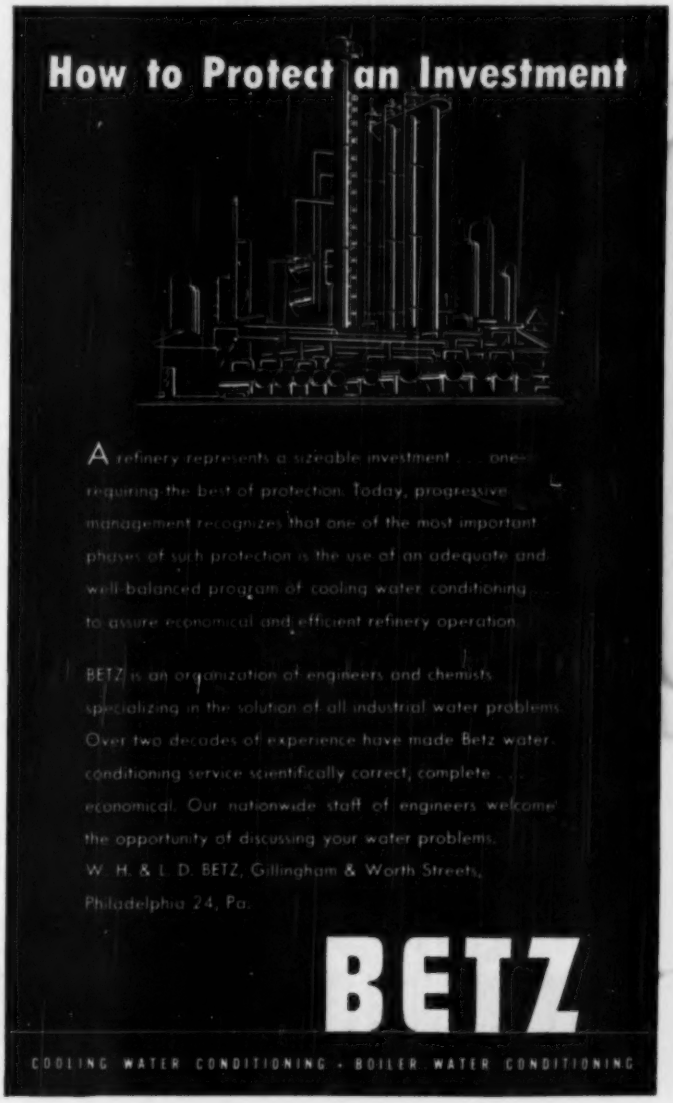
Aluminum chloride was found to cause rearrangement as well as replacement of fluorine by chlorine, when reacting with some saturated chlorofluorocarbons. The rearrangement reaction proceeds by an intramolecular mechanism and leads to the formation of compounds containing two or three fluorines on one carbon. The driving force for the rearrangement reaction appears to be formation of more stable halogen clusters.

Reaction of Iron with Organic Sulfur Compounds. Lyle A. Hamilton and W. W. Woods. *Ind. Eng. Chem.*, **42** (1950), pp. 513-9.

A better knowledge of the reaction of organic sulfur compounds with iron and other common metals is of importance in the fields of corrosion and extreme pressure lubrication. In the low temperature range, that is below 100° C., corrosion is generally associated with free sulfur, hydrogen sulfide, or polysulfides. In the range 125° to 275° C., many organic compounds that contain bivalent sulfur react with iron. The product appears to be principally ferrous sulfide. The extent of the reaction of sulfurized terpene hydrocarbons, sulfurized sperm oil, and n-dodecyl mercaptan with iron was compared in the temperature range 100° to 275° C. and an effort was made to establish a sulfur balance throughout the range. Experiments on the reaction of copper with several sulfur compounds are reported. Sulfur compounds are divided into two classes, based on extreme pressure lubricant tests. In one group the rate of reaction with iron appears to correlate with the effectiveness in these tests. However, compounds in the second group which react with iron at the same rate as those in the first group are quite ineffective in e.p. lubricants. Two different corrosion processes are apparently involved, but both terminate in the formation of the same iron sulfide. The difference between the two processes chemically is not known, but presumably a difference must exist. Results are presented in tabular and graphical form and a bibliography of 9 references is included.

Thiophene from Hydrocarbons and Sulfur Dioxide. R. E. Conary, L. W. Devaney, L. E. Ruidisch, R. F. McCleary, and K. L. Kreuz. *Ind. Eng. Chem.*, **42** (1950), pp. 467-71.

The synthesis of thiophene from hydrocarbons and sulfur dioxide by catalysis over molybdena-alumina, chromia-alumina, vanadia-alumina, molybdenum sulfide-alumina, and activated silica is described. It was found that the yield of thiophene was greatest from the normal C_4 hydrocarbons and especially from the olefins. When hydrocarbons of more than 4 carbon atoms in a straight chain are used, the products are alkyl thiophenes as well as thiopene itself. Since the reaction is exothermic the use of a fluidized catalyst system is advantageous, both in the synthesis of thiophene and in the regeneration of the catalyst. Operation using a fixed bed reactor system and also a fluidized bed system is described. The mechanism of the reaction has not been clearly established. However, it appears that oxidation, cracking, and isomerization occur simultaneously with the dehydrogenation-cyclization reactions. The hydrocarbon effluent when charging a straight C_4 hydrocarbon always contains butenes and butadiene, which suggests that these substances may be intermediate in the reaction. Somewhat higher yields from butene than from butane seem to confirm this idea. A bibliography of 9 references is given and the data are presented in detail in tabular and graphical form.


How to Protect an Investment
A refinery represents a sizeable investment . . . one requiring the best of protection. Today, progressive management recognizes that one of the most important phases of such protection is the use of an adequate and well-balanced program of cooling water conditioning . . . to assure economical and efficient refinery operation.
BETZ is an organization of engineers and chemists specializing in the solution of all industrial water problems. Over two decades of experience have made Betz water conditioning service scientifically correct, complete . . . economical. Our nationwide staff of engineers welcome the opportunity of discussing your water problems.
W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa.
BETZ
COOLING WATER CONDITIONING • BOILER WATER CONDITIONING

Is your refinery making money?

If your refinery is not making money, REFINERY ENGINEERING Company can show you what you can do to meet today's highly competitive conditions and show a profit.

A prominent refiner gave us a post war modernization contract and 77 days later this refinery was on stream. Recently this firm stated:

"Early this month (March 1950) our cat cracker put through its three-million six-hundred-thousandth barrel of gas oil, completing 365 days of continuous refining at 99 and 93/100 percent efficiency."

"Months ago we saw the trend to high octane motor fuels intensifying — and today we are better than ever able to supply refiners' and jobbers' exacting requirements — up to 82-95 research octane rating."

IT'S NOT TOO LATE!

Building a new refinery or remodeling your old may be the answer to greater profits through the years to come. You can make a determination of your needs and possibilities through a REFINERY ENGINEERING Company study of operating costs, yields, and profits on any proposed construction. Conferences with us will determine the proper type of plant to give you the greatest realization of profit and quickest return on your investment.

You can still have a cat cracker in 1951 if you place an order with REFINERY ENGINEERING Company NOW! CALL TODAY!

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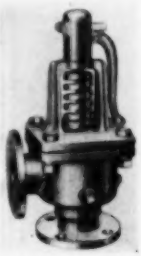
PHONE 5-5561 • TULSA, OKLAHOMA

NEW EQUIPMENT and Manufacturers' Literature

For copies of manufacturers' literature or more information about products described on these pages write to the address shown, using the number shown for each item desired.

Cast Carbon Steel Valve (Item 254)

A complete line of cast carbon and alloy-steel safety and relief valves has been added to the bronze line of Kunkle Valve Company. Typical valve, illustrated herewith, is cast carbon steel with a stainless steel trim for pressures to 600 pounds, temperatures to 650° F., sizes ¾ to 6 inches; ASA standard flanged inlet and flanged or screwed outlet. NB certified and ASME tested. Other valves for air, steam, gases, vapors and liquids in a wide range of pressures and temperature applications are described in a company catalog.



For a copy write Kunkle Valve Company, 111 So. Clinton Street, Fort Wayne 2, Ind.

Compressibility Charts (Item 255)

A series of compressibility charts covering the very broad pressure-temperature range usually encountered in engineering practice has been published in a booklet by Worthington Pump and Machinery Corporation. The charts are especially complete at low values of reduced pressure, according to the company. Also included are formulae developed applicable to gases that do not follow the perfect gas laws, in which compressibility factors shown on the charts may be used for estimating compressor horsepower and limiting throat pressures and weight flows for nozzles. There are five charts of large size in the booklet. They are drawn with extensive overlapping and with scales on the individual sections arranged to maintain a consistent accuracy in reading.

For further information write Worthington Pump and Machinery Corporation, Harrison, N. J.

Glass Blowing (Item 257)

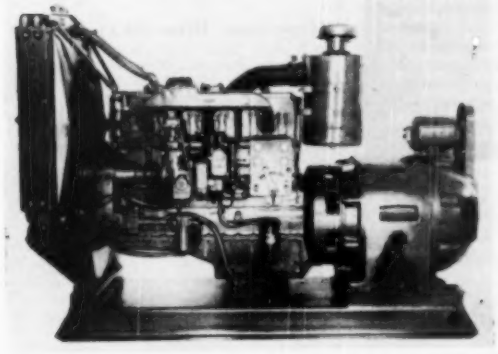
"Glass Blowing Equipment," a booklet issued by Scientific Glass Apparatus Company, Inc., covers basic tools, parts and apparatus in the laboratory glass blowing department. Stock items are shown with appended tables giving detailed specifications and current prices.

For a copy write Scientific Glass Apparatus Company, Inc., 49, Ackerman Street, Bloomfield, N. J.

Natural Gas Drying (Item 258)

Successful application of S/V sovabead, a new moisture-adsorbing chemical, in the commercial drying of natural gas before it is transported through pipelines has been announced by Socony-Vacuum Oil Company, Inc. Sovobead doubles the adsorption capacity of the drying towers. Initial tests consisted of establishing a full-scale commercial drying unit at Magnolia Petroleum Company's Dallas laboratories.

For further information write Socony-Vacuum Oil Company, Inc., 26 Broadway, New York 4.

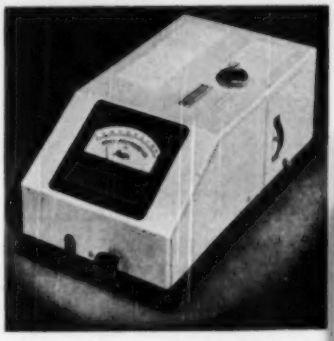


Generator Units (Item 256)

Diesel-powered electric generator units announced by Cummins Engine Company, Inc., are the alternating current type, 50-60 cycle, 3-phase, 3-wire, 3-phase 4-wire. Sixty-cycle units are offered in 40, 50, 60, 75, 100, 125, 200, and 250-kilowatt ratings. The unit consists of the engine direct connected to a single bearing generator, the engine and generator being mounted on a common structural steel sub-base. At full load of the generator, the engine delivers from 68 to 76 percent of the maximum hp. available at that speed, depending upon the kw. size of the generator and the engine used.

For further information write Cummins Engine Company, Inc., Columbus, Ind.

Colorimeter (Item 259)



Designed to speed routine processing analyses, the new industrial Rouy-Photrometer of E. Leitz, Inc., provides "the highest accuracy obtainable in colorimetric absorption analysis." The photoelectric colorimeter gives concentration readings in which inherent functional error is cut to within 0.1 percent. Matching of the photoelectric cell and the microammeter results in strict linearity of current vs. light energy. Identical readings on the same specimen can be obtained by different workers on different Photrometers. Each instrument is equipped with a set of ten compound compensating glass filters which are mounted in one rotating plastic disk which rotates within the Photrometer. Two blank spaces are provided for filters required in special work. Each filter and filter element is controlled in production and matched to produce identical transmission curves. It is a single cell, line-operated instrument adaptable to 6-volt d.c. operation and with four absorption cells, one sealed water absorption cell, plastic insert, dust cover and handbook.

For further information write E. Leitz, Inc., 304 Hudson Street, New York 13.

Rubber Coated Hood (Item 260)

Coated with a recently improved rubber, the fabric in General Scientific Equipment Company's new safety hood is said to be impervious to moisture, most acids, caustics, oils, and solvents and protects against extreme temperature and light metal splashes. The hood is fitted with a large plastic window for easy visibility and protects the worker's face, head and neck from dangerous sprays or splashing while working on acid storage tanks or pipe lines, etc. It may be worn with goggles or respirator. A supporting frame is embodied in the hood.

For further information write General

? HAVING TROUBLE PUMPING HEAVY OILS?
CONCERNED ABOUT LOSSES RESULTING FROM VOLUME SHRINKAGE AT LOW OIL DELIVERY TEMPERATURES? ...THEN INSTALL

Paracoil

TANK SUCTION HEATERS

TO SOLVE YOUR PROBLEMS

TANK SUCTION HEATER INSTALLATION

The shell is open at the inside end. The oil moves across the heating tubes as it passes through the shell to the suction connection outside the tank.

In Bulk Oil Terminals and Refineries the world over Paracoil Tank Suction Oil Heaters are licking the problem of economically preheating heavy viscous oils to permit their withdrawal from storage tanks. They are also preheating the lighter grades of fuel oils to their proper delivery temperatures to avoid the costly volume losses incurred when such oils are sold at low temperatures.

WITH PARACOIL TANK SUCTION OIL HEATERS

- **You Heat Only The Oil That Is Being Withdrawn From The Tank.** (Thus radiation losses resulting from heating entire tank contents are eliminated.)
- **Overall Steam Consumption And Heating Costs Are Held To A Minimum.**
- **Heater Tube Bundle Can Be Withdrawn For Inspection And Cleaning.** Breaking of oil suction line not necessary.
- **All Piping Connections And Gaskets Are Outside The Tank.**
- **U-Tube Design Permits Free Expansion And Contraction Of Tube Bundle.** Either high or low pressure steam can be used as the heating medium.

Prompt Shipments!
Our extensive stocks of tubing and pipe enable us to make quick deliveries to meet your immediate requirements.
Write for Descriptive Literature

SPEED UP DELIVERIES AND CUT OIL VOLUME LOSSES WITH PARACOIL TANK SUCTION HEATERS

In addition to the Paracoil Tank Suction Heaters, we also design and fabricate Line Type Discharge Heaters of any capacity. Illustrated is a Paracoil Straight Tube Type Fuel Oil Heater for bulk station service—capacity 2,000 gallons per minute, No. 6 oil, 100°F to 160°F, steam at 15 psig. Weight 12 tons.

DAVIS ENGINEERING CORPORATION
1060 East Grand Street, ELIZABETH 4, NEW JERSEY
30 Rockefeller Plaza, NEW YORK 20, N. Y.

New Equipment

Scientific Equipment Company, 2700 W. Huntingdon Street, Philadelphia 32.

Pail Closure and Spout (Item 261)

Flex Spout, a new leakproof, tamperproof closure and spout that seals directly on the pail metal with a single crimping operation, is described in folders of Rieke Metal Products Corporation. The new product meets ICC-17E specifications. The closure "will withstand greater internal pressures than the pail itself and will not breathe moisture." The spout is polyethylene, a tough, flexible plastic, unaffected by most chemicals and solvents at normal filling and shipping temperatures. The flexspout has a tamperproof metal seal which is broken and discarded upon first use of the container. After breaking the metal seal, the user removes a plastic screw cap, cuts out a thin plastic seal diaphragm and pulls out a flexible plastic pouring spot. The translucent spout allows observation of the flowing liquid. After use the spout can be sealed with the plastic screw cap. Also it can be pushed back to be flush with the container lid. Also described is the firm's ViseGrip drum closure.

For copies of the folders write Rieke Metal Products Corporation, Auburn, Ind., New York, Houston, or Los Angeles.

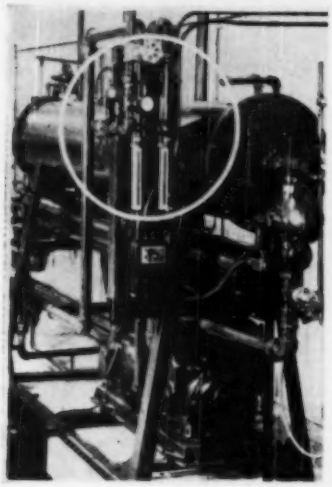
Dispersions (Item 262)

KEL-F dispersions, a new product of Kellogg Chemical Manufacturing Division of The M. W. Kellogg Company are being offered for industrial study so that they may be evaluated under actual commercial conditions. Included in a company booklet are properties and applications, characteristics, viscosity, contaminants, color, toxicity, and general information. Methods for applying the dispersions and fusion operation principle are also explained.

For further information write Chemical Manufacturing Division, The M. W. Kellogg Company, P. O. Box 469, Jersey City 3, N. J.

Flow Indicators (Item 263)

Selas Corporation of America flow rate indicators for air and gas, shown installed in a combustion type gas conveyor, measure components entering special atmosphere generators, and the cool protective gases delivered from



generators or from storage cylinders. When gas-air mixture ratios are required, these measuring devices are located upstream from the mixing equipment. In chemical industry applications, Flo-Scopes maintain proportions of gaseous ingredients entering synthesis and measure the flow for protective gases that prevent fires or slow oxidization of materials.

For further information write Selas Corporation of America, Philadelphia 34.

Threading Machines (Item 264)

"Tom Thumb" machines, one of two new lines of portable threading machines offered by The Oster Manufacturing Company, are designed for threading pipe ¼ to 2 inches standard range and bolts from ¼ to 1½ inches. All models have ½ hp., 6-pole universal motors, 7500 rpm. They include hardened and ground worms and bronze worm gears driven by 2 "V" belts through back gears. Anti-friction bearings are thruout. The "Rapiduction Jr." line has the same basic design but differs in dieheads and workholders. Die-heads are available as stationary, revolving, or automatic revolving. All four models, which thread straight or bent pipe and bolts, are equipped with 2 hp. constant speed motors, 900 to 1800 rpm.

For further information write The Oster Manufacturing Company, Cleveland, Ohio.

Plug Valve Lubricator (Item 265)

A simple device developed for automatically lubricating any make of lubricated plug valve from ½ to 20 inches in size is the new automatic plug valve lubricator made by Delta Engineering Sales Company. Composed of three simple stainless steel parts, the lubricator measures amount of lubricant into the lubricating channels of the valve each time it is opened and closed. The valve may be opened and closed 50 to 100 times before the reservoir must again be filled. To reset and refill with

These tools **go to the HEART of your MAINTENANCE problem!**

Keeping equipment "on stream" with minimum "time-out" for maintenance and repairs is the job of AIRETOOL products. The tools shown below are especially designed for refinery use. Maintenance crews and piece-work operators prefer their fast, safe operation.

TUBE ROLLING SYSTEM with the RIGHT motor size for your job

Our engineers will help you select the right electric motor to power this amazingly accurate tube rolling control system for condenser and heat transfer tubes. Each of the four motors shown is interchangeable with the control and produces results that surpass the performance obtainable from air motors. This greater tube rolling accuracy enables even the least experienced operators to meet production or piece-work schedules with greater dependability.

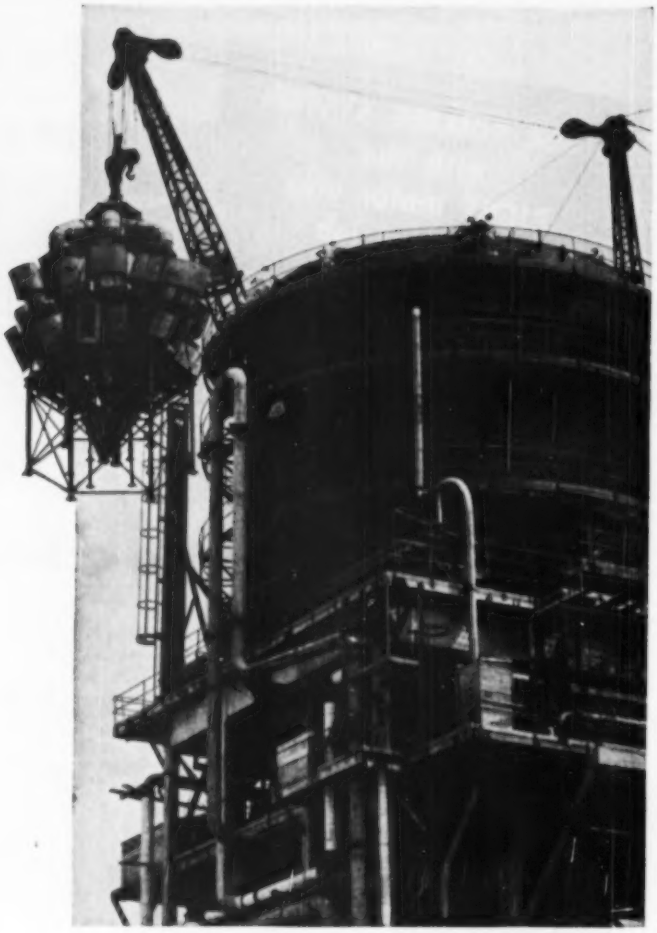
LONG CUTTING SURFACE REMOVES SCALE FASTER
This AIRETOOL cleaner with an expansion type head has three tiers of non-tracking cutters especially suited for removing severe coke deposits from still tubes. It is just one of many types of cleaners especially designed for tough maintenance jobs in refineries. For full information on tube cleaners, tube expanders and refinery accessory tools, write The AIRETOOL Mfg. Co., 316 South Center Street, Springfield, Ohio.

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

BRANCH OFFICES: New York, Philadelphia, Chicago, Houston, Tulsa, Baton Rouge

There's an AIRETOOL Tube Cleaner and Tube Expander for every type of tubular construction.

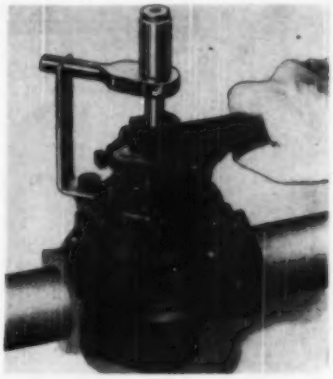
BUELL 'GOES TO THE TOP'
in catalyst recovery



In fluid or thermofor catalytic cracking Buell recovery systems have demonstrated continuous high-efficiency performance in all the major refineries. Design information is available on the latest multi-stage collectors. Buell Engineering Company, 70 Pine Street, Suite 5070, New York 5, N. Y.

buell
Engineered Efficiency in
DUST COLLECTION

MANUFACTURING IN UNITED STATES AND CANADA FOR SHIPMENT THROUGHOUT NORTH AND SOUTH AMERICA



lubricant takes only a few seconds, it is claimed.

For further information write Delta Engineering Sales Company, 806 Louisiana Avenue, Shreveport, La.

Vent and Drain Valve (Item 266)

A simplified ball-type seating mechanism instead of the customary disc, is contained in Crane Company's automatic vent and drain valve to assure more accurate seating and longer life. The valve is installed in water or oil piping systems to remove entrapped air, or in compressed air systems to remove water and oil. Operation is fully automatic. A range of sizes meets air requirements up to 150 psi. and water up to 125 psi. Body and cap of the valve are cast iron, the float, copper.

For further information write Crane Company, 836 S. Michigan Avenue, Chicago 5.

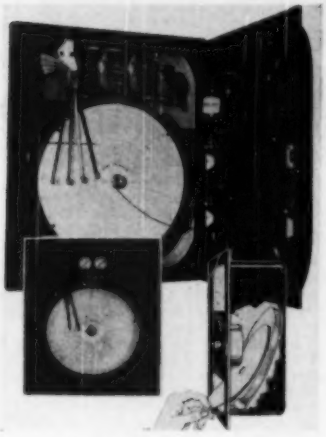
Spiral Nozzle (Item 267)

A 180° umbrella spray is obtained from the spiral nozzle developed by Bete Fog Nozzle Company for low flow rates and low pressure requirements. Its design is based on a non-clogging principle. Flow rates are controlled by interchanging a removable pin. Comes in sizes of ½ to 2 gpm. and for 1½ to 4 gpm. capacities.

For further information write Bete Fog Nozzle Company, Greenfield, Mass.

Recorders (Item 268)

Temperature measurement by the self-actuated tube systems of the gas-filled vapor tension and liquid-filled types for ranges from —100° F. to —800° F. are offered in Penn Industrial



Instrument Corporation's new and amplified line of pressure and temperature recorders. New case design accommodates up to four pens, any combination of temperature and pressure. Storage space is provided within the case for 200 charts and four bottles of ink.

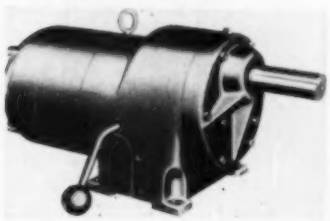
For further information write Penn Industrial Instrument Corporation, 3116 North Seventeenth Street, Philadelphia 32.

Heating System (Item 269)

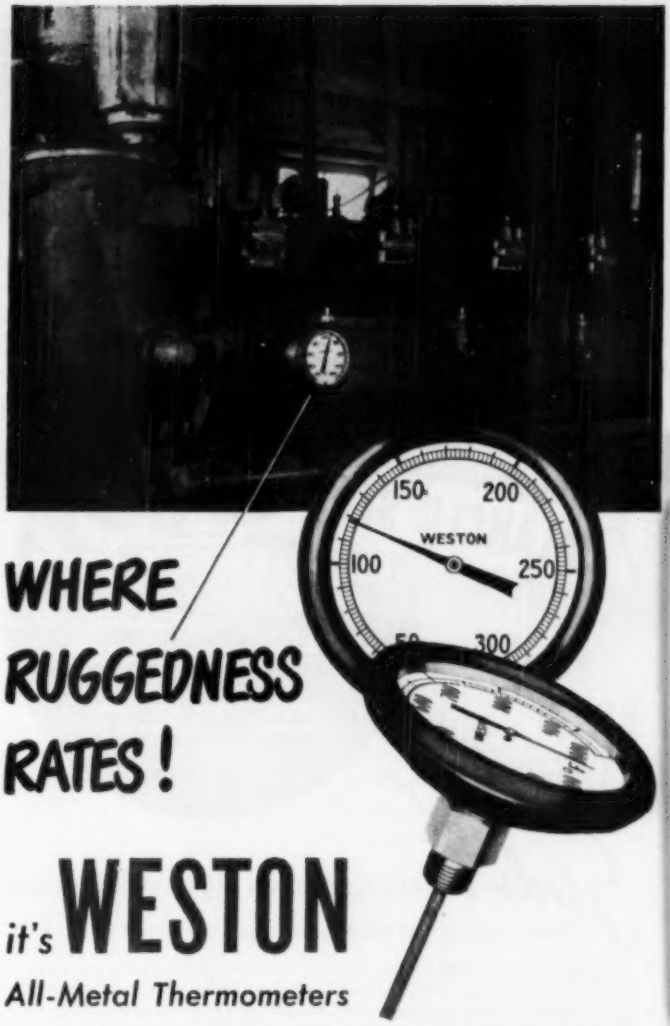
Application of the Dowtherm heating system in the process industries such as foods, plastics, resins, and chemicals is discussed in a brochure prepared by Foster Wheeler Corporation. The first section contains simplified flow diagrams, flow descriptions, and photographs of a representative group of processes. The second part describes Dowtherm used in the deodorization of edible oils; fatty acid distillation and fractionation; oil bodying; castor oil dehydration; synthetic resin manufacturing; esterification; phthalic anhydride distillation; sulfuric acid concentration; catalyst heating and regeneration and indirect air heating.

For further information write Foster Wheeler Corporation, 165 Broadway, New York 6.

Gearshift Drive (Item 270)



Type R3C gearshift drive motor of The Lima Electric Motor Company is a combination integrally mounted electric motor and a four-speed transmission having primary and secondary gear re-



WHERE RUGGEDNESS RATES!

it's WESTON

All-Metal Thermometers

Where the going is tough, WESTON thermometers get first call. Their rugged construction—all-metal throughout—enables them to stand up on pumps, compressors and mobile units. And the big, bold dials are easy to read—quickly and accurately! There are many types, stem lengths and scale ranges from which to choose. Ask your jobber or local WESTON representative, or write for Thermometer Bulletin. WESTON Electrical Instrument Corporation, 655 Frelinghuysen Avenue, Newark 5, New Jersey.

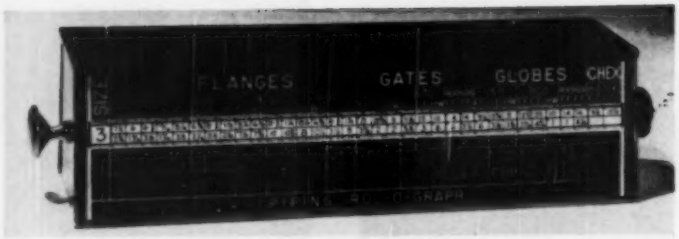
CONTACT-MAKING models for alarm or control purposes. MAX-MIN models to indicate highest or lowest temperature reached.

WESTON Instruments

ductions. Primary selective gear ratios of 4.15, 3.15, 1.85, and 1 to 1 are available. Secondary ratios are 2.25, 2.06, 1.89, 1.74, 1.60, 1.48, 1.36, 1.26, 1.17, 1.08, and 1.00. Full load motor speeds include 1730, 1140, and 865 rpm. Horsepower ratings are 1, 1½, 2, 3, and 5. Applications are included for individual motorization of mixing equipment and installations where low range selective speeds and high radial load capacity are required.

For further information write The Lima Electric Motor Company, Department AC 61, Lima, Ohio.

Piping Chart (Item 271)



The Piping Rolograph recently placed on the market by G. I. McBride, offers a tubular chart consolidating a large number of standardized piping dimensions. Made of plexiglas and measures about 2 by 2 inches, it is about 9 inches long and is planned particularly for the piping designer, draftsman or detailer and for fabricating shop layout men. A wide range of valve and fitting dimensions "make it a time-saving tool in refinery or chemical plant design. Pipe sizes from ½ through 24 inches are tabulated and are available for each pipe size by the rotation of a knob. All dimensions taken from the ASA code are so indicated on the chart.

For further information write G. I. McBride, 2844 East 99th Street, Cleveland, Ohio, or 2343 Coolidge Avenue, Oakland, Calif.

Chemical Proportioning (Item 272)

%Proportioneers, Inc.% in Bulletin CAT lists available bulletins reprints, standard methods, and instruction books concerning constant rate and flow responsive chemical proportioning.

For copies write %Proportioneers, Inc.%, P. O. Box 1442, Providence 1, R. I.

Pipe Coating (Item 273)

Polyken, an oriented polyethylene film with a synthetic adhesive on one side, is applied cold as a pipe coating. The tape material maintains a permanent pressure against the metal protected. The tape is applicable underground and above ground. Average coating resistance after backfill is over one million ohms per square foot.

For further information write Plastic Engineering & Sales Corporation, P. O. Box 1037, Fort Worth.

Blind Valve (Item 274)

The new Hamer Oil Tool Company "Rigid" line blind valve utilizes an internal sliding sleeve to seal against and release the spectacle plate without movement or expansion of the pipe line. Made of steel, the valves are available in ASA 150 and 300 pound classes in sizes from 6 to 12 inches. They are said to be especially suitable for all inflexible

hydraulically
BALANCED SEAL
Actual light hydrocarbon installation illustrates application of the John Crane balanced seal.

Seals propane and other light hydrocarbons

"Service-Proven" on Refinery and Pipe Line Installations

The "John Crane" Type 1 Shaft Seal will mean outstanding sealing performance on practically all your petroleum services, *including the effective sealing of Butane, Propane and other light hydrocarbons.*

This seal is being widely used today for all general petroleum services—is suitable even for pressures to 500 psi.

It is a single unit and requires no auxiliary lubricating system. Proper balancing of sealing faces, and the selection of proper face widths for each job insure leak-proof operation.

Based on our wide refinery and oil field experience, we usually recommend the single balanced seal, as shown above, with perfect mating faces and with enough flexibility to allow plenty of axial and radial movement. Numerous installations have shown that any pump in good working order, using reasonably clean fluid, can be successfully equipped with this seal.

Proof of its unequaled service is found in its use by many major refineries. Practically all leading pump manufacturers, too, agree that this seal is the best means for sealing hydrocarbons. Most manufacturers furnish it as standard equipment.

Stocks of seals and packings are carried in our offices listed below. Our engineers in 32 branches are on hand to look after your service requirements.

JOHN CRANE

CRANE PACKING COMPANY

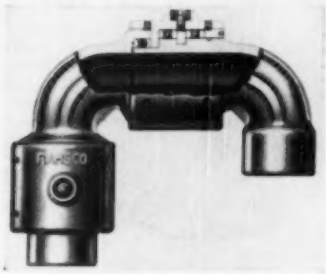
Houston: 6626 Supply Row, Houston 11, Texas
Chicago: 1820 Cuyler Ave., Chicago 13, Ill.
Los Angeles: 140 North Marine Ave., Wilmington, Calif.

Offices in All Principal Cities in United States and Canada

piping installations such as those in oil tankers and barges, refineries and process plants, and for large diameter lines.

For a copy of Bulletin 350 write Hamer Oil Tool Company, 2919 Gardenia Avenue, Long Beach 6, Calif.

Swivel Fittings (Item 275)



Ramsco ball bearing swivel fittings for rotation of 360° under pressure are offered by Rasmussen Manufacturing Company for high and low pressures, high temperature, and corrosive services. The fittings are available in single, double, and triple combinations. For high pressures up to 15,000 psi. at 225° F. sizes range from ⅜ to 6 inches. Sizes on low pressure fittings up to 1000 psi. at 225° F. are from ¾ to 14 inch. Withstanding temperature up to 1000 psi. at 750° F. the fittings can serve in steam, hot oil or asphalt, butane-propane or other liquefied gases, sulfuric acids and caustics. A company catalog lists sizes and prices.

For a copy write Rasmussen Manufacturing Company, 12307 Industrial Avenue, Hollydale, Calif.

Sample Containers (Item 276)

For either production run or laboratory sampling, the Hoke, Inc. stainless steel pressure sample containers are available in 400 and 1800 psi. Made of 18-8 stainless steel, they are ICC approved and may be obtained for single or double valving. On special order, they may be made of other metals, ferrous or non-ferrous.

For further information write Hoke, Inc., Englewood, N. J.

Student Microscope (Item 277)

Bausch & Lomb Optical Company Catalog D-185 describes the new Model FL student microscope available with coarse and low position fine adjustments, inclination joint, plain stage, substage diaphragm, and either mirror or integral illuminator. Six other models are described. All feature conventional substage mirror, integral substage illuminator, or both. A price list is included. A standardized method of model designations instead of catalog numbers are given for quicker and more accurate ordering.

For a copy write Bausch & Lomb Optical Company, Rochester, N. Y.

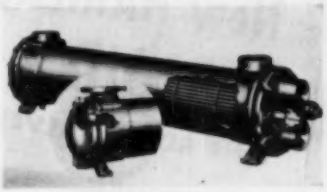
Pneumatic Transmitter (Item 278)

F-C pneumatic transmitter for liquid level, specific gravity, pressure, and flow is described in a folder of Instruments, Inc. Five models are shown with explanations of theory of operation, specifications and applications.

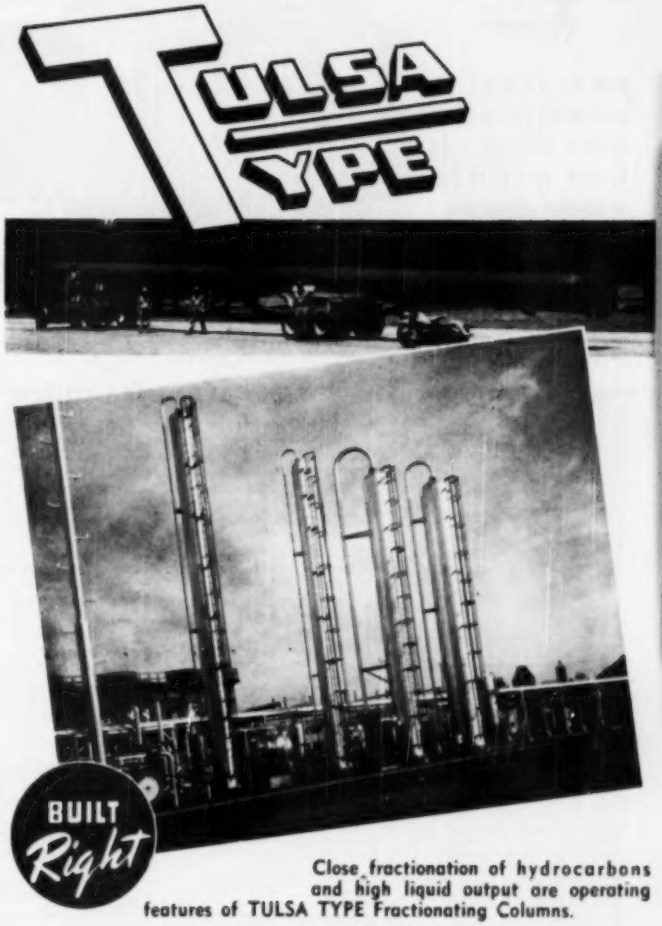
For a copy write Instruments, Inc., Tulsa, Okla.

Bundle Exchanger (Item 279)

A new line of standardized exchangers manufactured by Ross Heater & Manufacturing Company features all cuprous, removable tube bundle construction. Known as Type BCP, the exchangers also employ outside packed floating head, increased heat transfer surface. Exchangers are available in single or



two-pass or both. All sizes are equipped with integral brackets and suitable vents and drains for horizontal or vertical



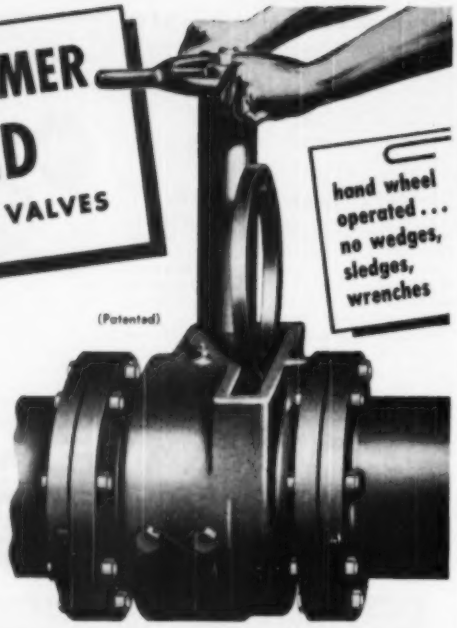
Close fractionation of hydrocarbons and high liquid output are operating features of TULSA TYPE Fractionating Columns.

TULSA TYPE is designed and fabricated to meet your specified operating conditions.

— Write for General Catalog —

FLINT STEEL CORPORATION
TULSA 1, OKLAHOMA

New HAMER RIGID LINE BLIND VALVES

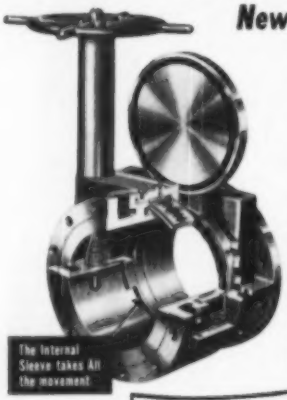


hand wheel operated... no wedges, sledges, wrenches

(Patented)

POSITIVE SHUT-OFF BY ONE MAN IN ONE MINUTE *without pipeline movement!*

Hamer RIGID Line Blind Valves solve the problem of effecting a positive blind shut-off in piping installations where endwise movement of the line is impossible. Now, for the first time, the advantages of the safe, speedy, one-man operated Hamer system of blinding can be incorporated in rigid pipe lines and manifolds in refineries, process plants, and on ship board, as original equipment in new installations, or as replacement of existing valves.



The Internal Sleeve takes All the movement

New Internal Expansion Feature

Face-to-face dimensions of Rigid Line Blind Valves conform to A. S. A. Standards for steel wedge gate valves and are not changed when releasing or sealing off the spectacle plate. An internal sliding sleeve, actuated by a ball-bearing mounted ring gear, takes all the movement and eliminates spreading the line.

Examine the cross section and you'll see these other important features. • *Enclosed plate slot*—eliminates loss of product, mess and fire hazard for fluid can't spill while plate is being reversed. • *Rigid body*—unaffected by misalignment or line strains. • *All working parts enclosed*—packed in grease for smooth action; sealed against line fluid. • *Positive shut-off or full-open fluid passage*—There's nothing like a Hamer Line Blind Valve for positive action, easy operation, long service and SAFETY.

SEND FOR CATALOG

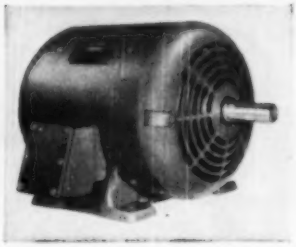
There is a Hamer Line Blind Valve for every blinding application. Illustrated below: 1—Spool-Type, side mounted head wheel. 2—Spool-Type, upright handwheel. 3—"Tee" and "Ell" Line Blind Valve. 4—Economy 3-Bolt Type.

HAMER LINE BLIND VALVES
Non-Stick PLUG VALVES
OIL TOOL COMPANY
2919 GARDENIA AVENUE, LONG BEACH 6, CALIFORNIA

mounting.

For a copy of Bulletin No. 2.2K1 write Ross Heater Manufacturing Company, Inc., 1407 West Avenue, Buffalo 13, N. Y.

Chemical Motors (Item 280)



New type CSP life-line motors especially designed for applications where corrosive fumes and liquids are encountered, are available from Westinghouse Electric Corporation. Rotating neoprene slingers on the shafts between rear brackets and hoods are used to prevent the entrance of dirt or liquids into the bearing housings. Frames, brackets, hoods and other exposed parts are alkali-cleaned, hot-water rinsed, then rinsed in chromic acid spray. After drying, they are sprayed with phenolic-alkyd-type enamel and baked. A coat of gray enamel and two to four baked dips of thermoset varnish are followed by a final coat of gray lacquer.

For further information write Westinghouse Electric Corporation, P. O. Box 2099, Pittsburgh 30.

Flame Hardening (Item 281)

"Oxyacetylene Flame Hardening in Commercial Heat Treatment," a reprint offered by Air Reduction Sales Company, a division of Air Reduction Company, Inc., covers the range of materials which may be oxyacetylene flame hardened, and outlines the various flame hardening methods. Typical applications of the process and hardness tables are also included.

For a copy write Air Reduction Sales Company, 60 East 42nd Street, New York 17.

Steam Plant Equipment (Item 282)

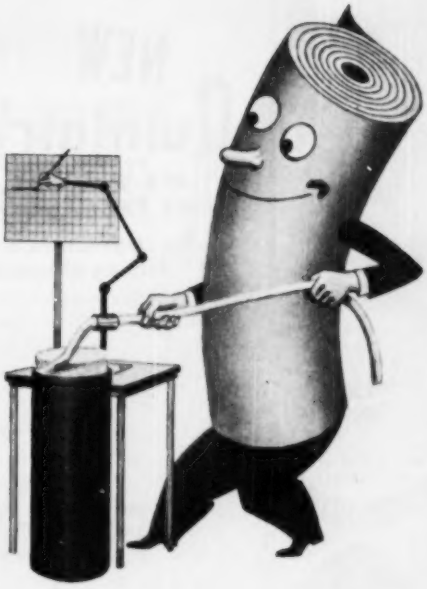
Blow-off valves in low, medium, and high pressures are described in Yarnall-Waring Company's Bulletin G-1307 on steam plant equipment for utilities, industrial plant and institutions. Other items described are water columns and gauges, liquid level indicators and recorders, expansion joints, steam traps, strainers and spray nozzles, and research facilities.

For a copy write Yarnall-Waring Company, Chestnut Hill, Philadelphia 18.

Floating Roofs (Item 283)

Three types of Horton floating roofs—double-deck, pontoon and pan—are described, and the service for which each roof is used is discussed in "Horton Floating Roofs" offered by Chicago Bridge and Iron Company. Included is information on the reduction of evaporation loss and corrosion and the elimination of fire hazards in flat-bottom tanks

CHECKING EVENNESS OF ROVING WITH LINEAR REGULARITY TESTER. One of a series of laboratory controls throughout production to assure fabric uniformity in all Mt. Vernon-Woodberry products.



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AIR COOLED HEAT EXCHANGER

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TYPE SR

● In ever increasing numbers, designers and users of process vessels in many fields—food, beverage, paint, pharmaceutical, oil, etc.—are turning to Lenape for preferred variations in standard manway necks and nozzles.

Construction employs standard Type R Necks or Nozzles with covers, hinge or davit, and toggle bolts.

Special bronze trim for marine use, babbit joint for spark proof service, view or sample ports, etc. are provided when specified.

Send for special Bulletin 4-82, price schedule M488 and pending complete new catalog 9-49.

Top Unit: Standard SR Neck with Quick-opening sample port. Lower Unit: SR Neck frame only, with toggle bolts and special hinge for flame barrier screen lid installed by purchaser.

LENAPE HYDRAULIC PRESSING AND FORGING CO.

LENAPE HYDRAULIC PRESSING & FORGING CO.
DEPT. 106 WEST CHESTER, PA.

New Equipment

storing volatile liquids and chemicals. Cutaway views, typical plant views, and cross section sketches illustrate the construction of the roofs and accessories included with each installation.

For a copy write Chicago Bridge and Iron Company, 332 South Michigan Avenue, Chicago 4.

Polarizing Microscopes (Item 284)

Twelve new Spencer polarizing microscopes incorporating Polaroid optical elements in place of calcite are announced by American Optical Company's Instrument Division, Buffalo, N. Y. The Polaroid elements, according to the company, "have been well accepted by petrographers and chemical microscopists who have found their performance to be outoutstanding in durability, resistance to heat, sensitivity of extinction point, freedom from residual color, and image contrast." The Polaroid elements have been used for five years in eight Spencer microscopes. Also offered are twelve instruments with calcite prisms, and eight microscopes on which the Polaroid elements were first incorporated. All models are now available.

For further information write American Optical Company, Southbridge, Mass.

Lithium Chemicals (Item 285)

"Lithium in Modern Industry," reviews and forecasts significant developments in lithium chemistry since 1940. Edited by the staffs of Foote Mineral Company, this volume discusses the chemistry of lithium, and lithium salts, the industrial applications of lithium compounds and newer uses of these materials. Also included is a bibliography of technical references and numerous tables etc.

For a copy write Foote Mineral Company, 18 W. Chelten Ave., Philadelphia 44.

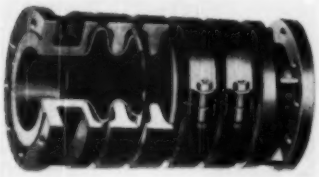
Steel Boiler Tubes (Item 286)

A new bulletin of technical data on electric-resistance-welded steel boiler tubes, announced by The Babcock & Wilcox Tube Company contains tables on maximum allowable working pressures, conforming to ASME specifica-

tion SA-178, for different diameters and gauges of tubes for water-tube and fire-tube boilers. Another table determines the weight in pounds per lineal foot of steel tubes in various minimum wall sizes.

For a copy write The Babcock & Wilcox Tube Company, Beaver Falls, Pa.

Corrugated Joints (Item 287)



Corrugated expansion joints of Chicago Metal Hose Corporation, help control expansion and contraction caused by temperature changes in pipelines. These joints are especially suited for trenches, tunnels and locations where space is at a premium. Joints of copper, stainless steel, or other alloys are available in complete size range from 3 to 24 inches i.d. Units are fabricated with single or multiple corrugations and with or without control rings. Flanged or welding ends may be used. Units with stainless steel inner liners, tie rods and special flanges and welding combinations are included in the line.

For further information write Chicago Metal Hose Corporation, Expansion Joint Division, 1306 South Third Avenue, Maywood, Ill.

Control Devices (Item 288)

"Industrial Control Devices," for temperature, flow, pressure, liquid level and humidity, Catalog 8303 of Minneapolis-Honeywell Regulator Company, describes 100 different models of non-indicating electric, electronic, and pneumatic controllers. New additions shown include electronic temperature controllers, self-contained electric temperature controllers, and pneumatic insertion type temperature controllers; magnetic starters and contactors; heavy-duty pneumatic positioning motors; pneumatic automatic reset relays and electric step controllers.

For a copy write Minneapolis-Honeywell Regulator Company, Industrial Division, Wayne and Windrim Avenues, Philadelphia 44.

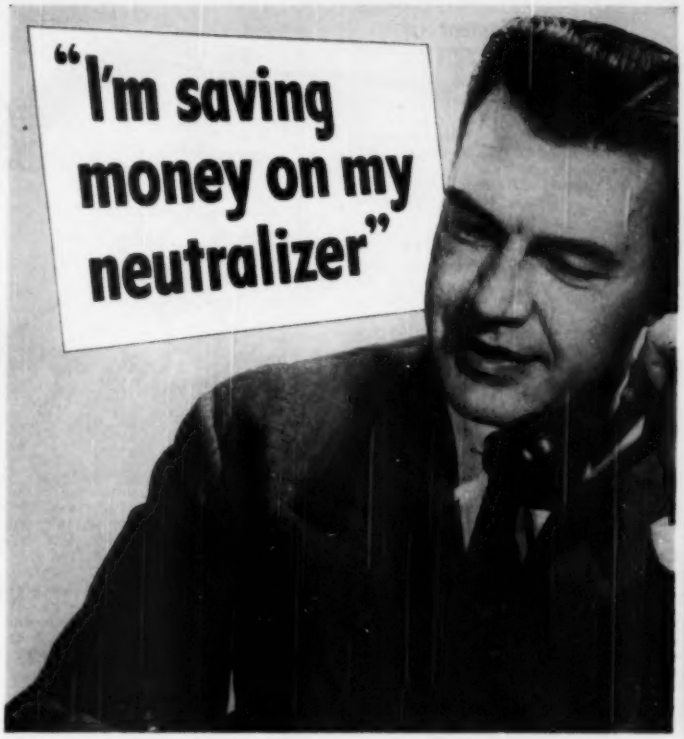
Caustic Soda (Item 289)

"Mathieson Caustic Soda," a new 48-page book covers phases of manufacture, economics, properties, handling and application of this product.

For a copy write Mathieson Chemical Corporation, Mathieson Building, Baltimore 3, Md.

Engineering Data (Item 290)

Sizing charts to determine the correct size of Hammel-Dahl Company valves for liquids, steam, or gas are given in Bulletin No. 200. The sizing charts can be used for both single and double-seated valves of any body rating, 125 pound ASA standard cast iron to 1500 pounds



"I use Barrett Standard Anhydrous Ammonia to neutralize acidity in oil refining. This liquefied gas, guaranteed to be of the highest purity, is one of the lowest cost neutralizing agents delivered to the refinery. One pound will neutralize the same quantity of acid as several pounds of other neutralizing agents.

"Easily vaporized, Barrett Standard Anhydrous Ammonia follows the gas stream through the equipment, neutralizing corrosive acids as soon as they are formed. It has high solubility and a high rate of diffusion in oil. It destroys acidity without the formation of water or undesirable emulsions. Products of neutralization are easily eliminated from the oil. Excess ammonia is removed by blowing the oil with air."

You, too, can save money by using Barrett Standard Anhydrous Ammonia—available in 50, 100, and 150-pound cylinders, and in tank cars. Get all the facts! Write, wire or telephone the address below.

THE BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 RECTOR STREET, NEW YORK 6, N.Y.

Barrett
STANDARD ANHYDROUS AMMONIA
Reg. U. S. Pat. Off.

ASA standard cast steel. The charts are based on the use of a plug design with linear characteristics when percent of maximum plug lift is plotted against percent of maximum flow on rectangular coordinate paper.

For a copy write Hammel-Dahl Company, 243 Richmond Street, Providence 3, R. I.

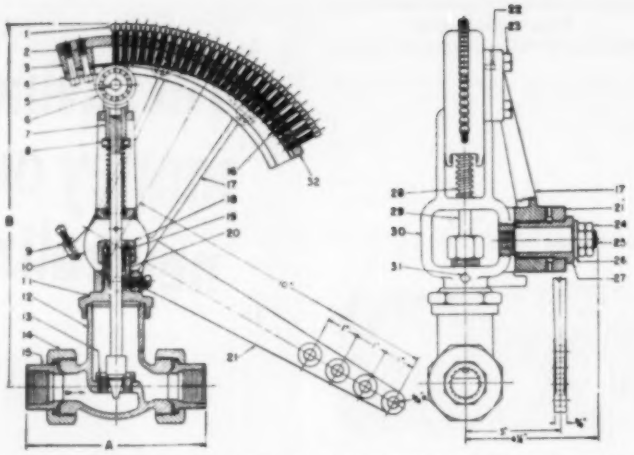
Humidity Control (Item 291)

Utilizing the psychrometric wet and dry bulb principle, the controller of Weston Electrical Instrument Corporation automatically regulates the wet-bulb (relative-humidity) depression for which it is set, regardless of any fluctuation in the dry-bulb temperature. Two pens operate on a circular 10-inch chart, simultaneously recording the dry-bulb temperature and the wet-bulb depression. The flow of the humidifying agent, moisture, steam or oil fog, is regulated by a valve which is operated by the control instrument.

For literature write Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J.

Control Valve (Item 292)

The problem of maintaining desired flow ratios between two variables can be met by a special lever operated control valve of The Atlas Valve Company. An adjustable cam provides an easy method of setting valve lift as desired for any lever angle. The valve thus gives the desired ratio of flow between



two streams and over a wide range. A flexible cam sheet (16) attached at one end to the cam arm (17) is rotated by lever (21). The curvature of the cam sheet is adjusted by a series of screws (1). A roller (6) is attached to the valve stem (29) and is forced upward against the cam sheet by spring (28). The valve seats are available in steps of 1/16 inch diameter in single seated valves, and steps of ⅛ inch in double seated valves.

For further information write The Atlas Valve Company, 282 South Street, Newark, N. J.

Gas-Shielded Welding (Item 293)

Advantages of the inert gas-shielded arc welding process and the metals for which it can be used are described in Folder F-7013 of The Linde Air Products Company. Main features and specifications of Heliarc apparatus is discussed. Illustrations show five models of the torch for manual and mechanized operation, new argon regulator and argon flow meter, especially designed to give accurate gas flows, ceramic and water-cooled shielding-gas cups, electrodes, and the argon-water shut-off

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Specialized experience of over 35 years in the building of Pressure Vessels for Natural Gasoline Plants, Refineries and Chemical Plants, places VULCAN in the foreground for Leadership in Quality, Workmanship and Maximum Ultimate Service.

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in all Petroleum Processing Conditions

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Refinery Tubing

A Wide Choice of Service-Proved Analyses to meet ALL conditions of corrosion, pressure, temperature and oxidation

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Croloy ½	(½% Cr. ½% Mo)
Croloy 1¼	(1¼% Cr. ½% Mo)
Croloy 2	(2% Cr. ½% Mo)
Croloy 2¼	(2¼% Cr. 1% Mo)
Croloy 3-M	(3% Cr. 1% Mo)
Croloy 5	(5% Cr. ½% Mo)
Croloy 5-Si	(5% Cr. ½% Mo. 1½% Si)
Croloy 5-Ti	(5% Cr. ½% Mo. ½% Ti)
Croloy 7	(7% Cr. ½% Mo)
Croloy 9-M	(9% Cr. 1% Mo)
Croloy 18-8-S	(18% Cr. 8% Ni)
Croloy 16-13-3	(16% Cr. 13% Ni. 3% Mo)
Croloy 25-20	(25% Cr. 20% Ni)

Ask your B&W Tube Representative for detailed technical and application data on any analyses you may require.

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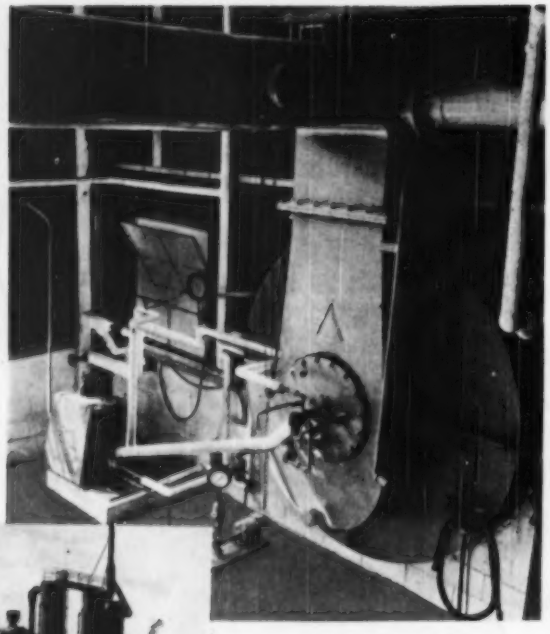
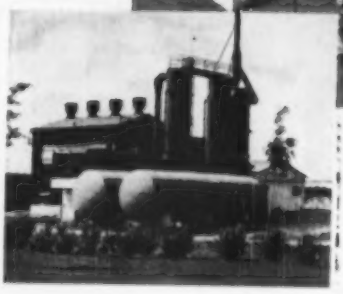
TA-15838

fifty ton H_2SO_4 plant





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When you intend modernizing, expanding, or building an acid plant or other chemical facilities—of any size—anywhere—it will be worth your while to investigate the type of services being rendered by our organization. We furnish all required equipment and materials *COMPLETE*—engineering, drafting, construction, supervision of operations, training of operating personnel, consultations, and periodic inspections. Write today for details. No obligation.

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CORPORATION

11 West 42nd Street **New York 18, N. Y.**

New Equipment

valve. The process theory is also explained.

For a copy write The Linde Air Products Company, 30 East 42nd Street, New York.

Current Controller (Item 294)

The Cono Model "EB" current pneumatic controller developed by Conoflow Corporation permits the use of standard industrial pneumatic controllers on applications involving electrical components as the final controlled element. This controller utilizes a standard electrical component modified for continuous throttling control service and new cylinder operator which includes an integrally mounted positioning device to provide accuracy and sensitivity of positioning to within 1/500 part of its total travel. The controller is also used in conjunction with a small Rheostat-Potentiometer.

For further information write Conoflow Corporation, 2100 Arch Street, Philadelphia 3.

Safety Heads (Item 295)

"BS&B Safety Head Price List," 16 pages, explains sizes, ratings and specifications of safety head flanges, rupture discs, vacuum supports, refrigerant relief valves, pressure-vacuum vent valves, and combined vent valve-flame arrestor units. Also included are examples on how to order the various sizes of safety heads and accessories.

For a copy write Black, Sivalls and Bryson, Inc., 720 Delaware, Kansas City 6, Mo.

Swivel Coupling (Item 296)

Gil-Lair Products, Inc., announces its new Catalog No. 50 which describes the design features, gives complete specifications, working pressures and prices of its complete line of high-pressure and low-pressure All-Flex ball bearing swivel pipe couplings. Eight basic styles are available in sizes from ⅜ to 12 inches and for pressures from vacuum to 12,000 psi. Also described are a steel rotary hose, steel cementing hose, mud mixing guns, marine and barge hose and steel circulating heads.

For a copy write Gil-Lair Products, Inc., 81 Masonic Court, Pasadena, Calif.

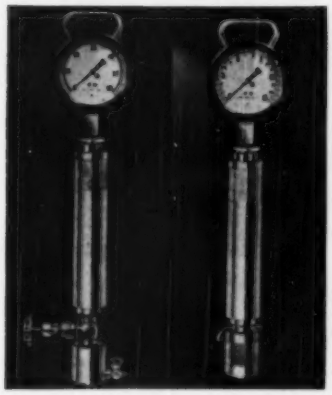
Single-Stage Turbine (Item 297)

Initial pressures to 1450 psig., initial temperatures to 950° F. and back pressures to 300 psig. are claimed for De Laval Steam Turbine Company's first standard single-stage turbine using all labyrinth shaft sealing. The turbine is supported at the true centerline and the front end is mounted on a flexible channel, permitting both radial and axial ex-

pansion to take place without disturbing the shaft centerline. The turbine can be furnished with governors including mechanical shaft, vertical flyweight with or without oil relay; hydraulic with or without oil relay; pressure governors for pump and blower drives and auxiliary tripping devices.

For Bulletin No. 4215 write De Laval Steam Turbine Company, Trenton 2, N. J.

Vapor Pressure Bombs (Item 298)



Precision Scientific Company has developed light weight Reid vapor pressure bombs suitable for testing aviation gasolines according to the revised ASTM method D-353-49. The bombs are suitable for ordinary gasoline, benzol blends and volatile liquids. The volume ratio of the air chamber to the gas chamber has been held within the close limits set for testing aviation gasolines. The immersion sampling bombs, 15 by 2 inches, weigh three pounds; the pressure sampling bombs 16½ by 8 inches total 4½ pounds. Precision Bourden-type Reid gages are guaranteed accurate to within 0.5 percent of the scale range, have stainless steel mechanism.

For further information write Precision Scientific Company, 3737 W. Cortland Avenue, Chicago 47.

Oil and Gas Separators (Item 299)

Bulletin 201 featuring Peerless Manufacturing Company oil and gas separators explains fabrication of Peerless separators and special design separators to meet specific needs. Specifications of high-pressure separators as well as oil capacity tables and gas capacity tables are included in Bulletin 203. In Bulletin 204 the Peerless solution to the problem of the separation of foaming crude oil and the separation of oil at high pressures is discussed. Bulletin 101 features line separators, explaining the line separator principle.

For copies write Peerless Manufacturing Company, P. O. Box 7193, Dallas.

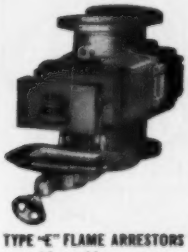
Water Coolers (Item 300)

Built to comply with requirements for hazardous locations, in refineries, distilleries, paint-chemical and powder-

OCECO FITTINGS

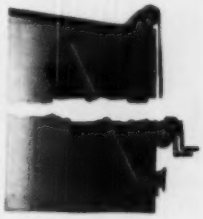
Prevent VAPOR AND FIRE Losses

● Specify Oceco Fittings *throughout* for *all* your tanks — and get proven, dependable, trouble-free protection—for only a fraction of one per-cent of the value of the tank and its contents. Send for the Oceco Data Sheets. They give full specifications, and complete listings of sizes, weights, dimensions, etc.



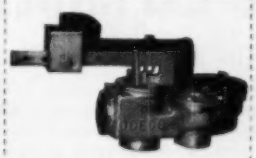
TYPE "E" FLAME ARRESTORS can withstand long exposure to fire. The "banks" have vertical straight through passages — *minimizing* entrainment and pressure drop, and are "extensible" for easy cleaning. 2" to 10" sizes.

TYPE "BE" VENT UNITS consist of a V-113 Vent Valve with snuffer, mounted on a Type "E" "Extensible" Bank Flame Arrestor. 2" to 10" sizes. Unsurpassed for efficiency and reliability.



SWING LINE EQUIPMENT — complete facilities including heavy duty tank nozzles; efficient double elbow swing joints; swing pipes; cable clamps; cables; sheave brackets and internal or external winches.

V-100 EMERGENCY PRESSURE RELIEF VENTS provide instant relief for excessive internal pressures, resulting from exposure fires, etc. Furnished in 6", 8", 10", 15¼" and 20½" sizes.



V-100 STILL TYPE VALVES combine vacuum and pressure relief in a single valve. 3", 4" and 6" sizes. Pressure settings from 2 to 25 lbs. per sq. inch. Vacuum settings from 1 oz. to 10 oz. Temperatures up to 600° F.

V-114 INTERNAL TANK VALVES are provided with a fusible link that melts when subjected to fire, closing the valve instantly, and cutting off the flow from the tank. 3", 4", 6", 8", 10", 12" and 16" sizes.

Please note the new address!

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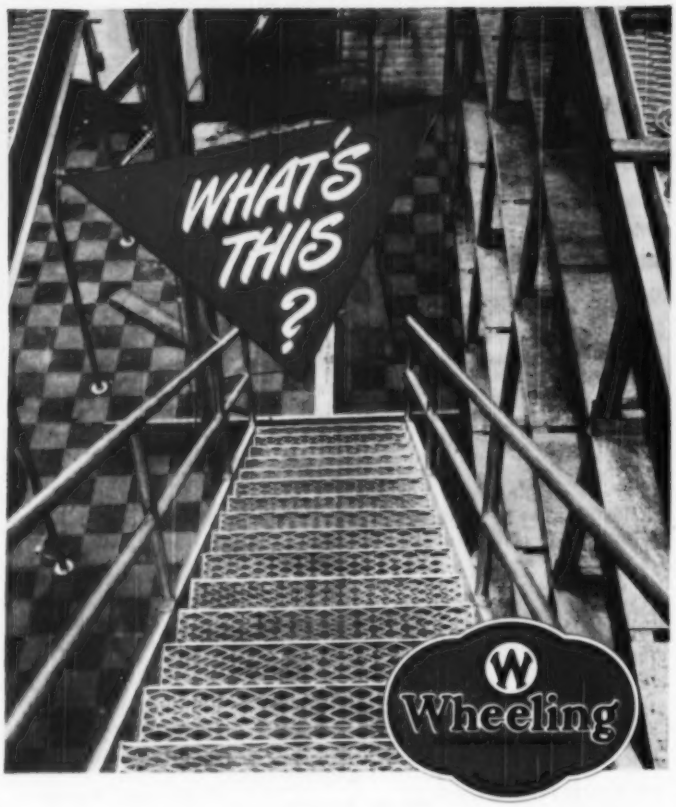
THE JOHNSTON & JENNINGS CO.

4700 West Division Street • Chicago 51, Illinois

★ *division of* PETTIBONE MULLIKEN CORPORATION ★



Non-skid floor and stair treads made of

WHEELING EXPANDED METAL

"Material of a thousand uses"

Prevent slipping accidents with Wheeling ExM's underfoot security on floor and stairs, as in this laundry. Its criss-cross, non-slip design gives a sure grip to walkways, platforms, stairways. The strength of this modern construction material is another safety factor.

Made in many types, weights and mesh sizes . . . stronger than sheet metal of the same weight. Use ExM for property protection, tool room enclosures, partitions, tellers' cages—it does not cut off light and air.

Prevent accidents by using it for machine guards, radiator guards, window and skylight protection.

Excellent also for grilles, lockers, bins, parts trays and baskets. Easily formed to fit every need. *Write us for information.*

WHEELING CORRUGATING COMPANY

WHEELING, WEST VIRGINIA

Atlanta · Boston · Buffalo · Chicago · Cleveland
Columbus · Detroit · Kansas City · Louisville · Minneapolis
New Orleans · New York · Philadelphia · Richmond · St. Louis

New Equipment

plants, explosion proof electric water coolers with capacities ranging from 10 to 40 gallons per hour are announced by Filtrine Manufacturing Company. A life expectancy of 20 years is claimed. Drinking fountains feature additional bubbler stations and reinforced angle steel frames.

For literature write Filtrine Manufacturing Company, 53 Lexington Avenue, Brooklyn 5.

Chemical Pumps (Item 301)

Centrifugal pumping equipment used in chemical process industries is described in Worthington Pump and Machinery Corporation's Bulletin W-350-B11. Pumps shown include those for corrosive liquids, standard antaciron, refineryy type pumps, monobloc, KEB and KED elbow-propeller pumps and worthite valves. Other products listed for handling corrosive liquids and gases are ejectors, hot-rolled bars, coated welding rod, Hex nuts, and castings. Also described are the company's mechanical seal, specially designed to prevent leakage of corrosive liquids, and "Worthite," a corrosive-resistant metal.

For a copy write Worthington Pump and Machinery Corporation, Harrison, N. J.

Steam Trap Drainage (Item 302)

A revolutionary new development in steam trap construction, called Duo-Step Leverage, has been introduced by The Clark Manufacturing Company. By using a double fulcrum point and venting mechanism it is possible to increase the drainage capacity of a trap "so that it may handle twice the condensate formerly possible."

For further information write The Clark Manufacturing Company, 1830 E. 38th Street, Cleveland 14, Ohio.

Combustibles Recorder (Item 303)

Design improvements and new applications for Bailey Meter Company's combustibles recorder are featured in bulletin 150-A. This electronic-type instrument operates on the catalytic combustion principle and serves boiler furnaces, atmosphere producers, rotary kilns, industrial furnaces, and chemical processes. Either air or electrically-operated control of combustibles content may be had with with the combustibles recorder.

For a copy write Bailey Meter Company, Cleveland 10, Ohio.

Fire Extinguisher Chart (Item 304)

Ansul Chemical Company offers a periodic inspection chart for helping fire inspectors keep accurate records of extinguishers. Space for 26 inspections of up to 38 extinguishers is provided.

For a copy write Ansul Chemical Company, Marinette, Wis.

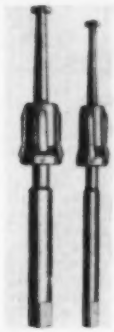
Lighting Guide (Item 305)

A planned lighting equipment selection guide, clarifying the application of the 12 basic industrial lighting systems for general lighting, offered by Benjamin Electric Manufacturing Company, is designed for use by electrical contractors,

lighting specialists, and industrial executives and includes a check list containing 11 benefits to be derived through the application of planned lighting to industrial operation. A separate chart shows the application of units for installation in locations with combustible, dusty or damp atmospheres.

For a copy write Benjamin Electric Manufacturing Company, Des Plaines, Ill.

Tube Expanders (Item 306)



Two new style Series 900 ideal rolling and flaring tube expanders have been developed by The Gustav Wiedeke Company for the installation and maintenance of superheater and small tubes in high and low pressure water tube and other boiler units. Expanders can be supplied with header mandrels 19 inches long, drum mandrels 12 inches long and Shot Mandrels 7 inches long to meet the varying conditions. Bulletin No. 68 gives details and specification data and also describes improved series 1500 ideal tube expanders and operating accessories.

For a copy write The Gustav Wiedeke Company, Richard Street, Dayton 1, Ohio.

Multi-Stage Pumps (Item 307)

Multi-stage centrifugal pumps, Type OSMH for boiler feed and high-pressure service are adaptable to electric motor, steam turbine or engine drive. Twelve operating features are explained in an enlarged cross-section contained in Bulletin 382 of American-Marsh Pumps, Inc. Construction, modifications and approximate general dimensions are given in table and diagram. Type HHM, two-stage units, is also shown.

For a copy write American Pumps, Inc., Battle Creek, Mich.

Calibrating Tank (Item 308)

Excel-So 50-gallon "Squatty" meter calibrating tank is recommended by its manufacturer, Warner Lewis Company for 35 and 50 gallon truck meters, but is also available in 84, 100, and 150-gallon capacities with low silouettes. Models described in Bulletin No. CT 101-50 range from 50 to 2000 gallons and 2-5-10-15-20 and 30 barrels, in either stationary or portable with or without springs, open or closed type necks, and with electric or pneumatic brakes. All designs in accordance with API Code 1101.

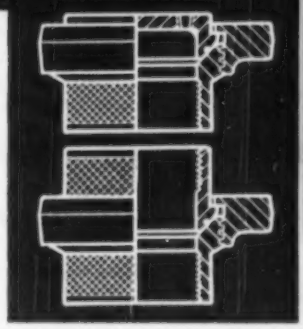
For a copy write Warner Lewis Company, Box 3096, Tulsa.

Buying Wood (Item 309)

The Dow Chemical Company has issued instructions covering recommendations for buying wood treated with formulations of pentachlorophenol to resist the attack of decay, fungi, wood-destroying insects and dimensional changes

WECO
FIG. 208
BLANKING UNION

with "O" Ring is ideal for mainfolding, terminal installations, transfer lines, scraper box and jumper assembly service. It has less bulk . . . less weight. All parts completely interchangeable. Available in 4", 6", 8" and 10" sizes.



Ask your WECO representative or write for complete details and wide range of applications of WECO Fig. 208 Blanking Union.

WECO
WELL EQUIPMENT MFG. CORP.
HOUSTON 1, TEXAS
CHIKSAN COMPANY

Here's why Petroleum Refiner is wanted by so many refinery men—

THOROUGH coverage of current technical and economic thought in the field of petroleum refining, natural gasoline and petrochemical manufacturing.

PRACTICAL articles written by outstanding authorities of the industry.

"SHORT CUTS" published under the heading of "How To Do It" which bring you practical suggestions which have already made and saved money for other companies.

DETAILED data on new processes and improvements on old ones.

INFORMATION on practical as well as theoretical phases of process plant design and operation.

A REVIEW of technical literature on refining, natural gasoline and petrochemical manufacturing making quickly available the source of additional data on a subject of particular interest.

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(ESTABLISHED 1922)

	U. S. & Canada	Latin America	Overseas
☐ 3 yrs. for	$4.00	$16.00	$20.00
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Name_____

Street and No._____

City and State_____ Zone_____

Company_____ Engaged in ☐ Refining ☐ Natural Gasoline Mfg.

Position_____

Equipment . . . . . or . . . . . Other Classification—**please identify**

☐ Manufacturer
☐ Supply Company
☐ _____

Return to P. O. Box 2608 Houston 1, Texas

New Equipment

caused by excessive moisture or lack of moisture. The guide covers woods treated by pressure, hot and cold immersion, Dri-Vac, cold soaking, and dipping.

For a copy write The Dow Chemical Company, Midland, Mich.

Pneumatic Positioning (Item 310)

"Pneumatic Operators", Conoflow Corporation, covers the field of pneumatic positioning devices for throttling control service. Design, application, fundamental principles of operation and features of construction are included for spring and diaphragm type of operator, springless Conomotors, pneumatic cylinders, and the pneumatic positioning device called the Rotomotor.

For a copy write Conoflow Corporation, 2100 Arch Street, Philadelphia 3.

Forged Steel Valve (Item 311)

Inclined stem design for low flow resistance, low pressure drop, minimized wear on seat and disk are features incorporated in Edward Valves, Inc.'s new line of small globe and angle valves. Bolted gland construction with swivel type forged steel gland bolts includes bronze bushing in bonnet yokes, permanent backseats, and microscopically mated seats and disks.

For further information write Edward Valves, Inc., East Chicago, Ind.

Sump and Jet Pumps (Item 312)

Automatic electric sump pumps, explosion proof and totally enclosed, are described in Specification No. 4929 of Penberthy Injector Company. Constructed of copper and bronze throughout, they are made in five sizes for different sump depths. Bulletin No. 5030 describes cycling jet pumps operated by air, gas or steam pressure.

For copies write Penberthy Injector Company, 1242 Holden Avenue, Detroit 2, Mich.

Open Steel Flooring (Item 313)

Flooring in rectangular and triangular reticulated patterns for platforms, walkways, bridges, safety steps, drain grates, trench covers, pallets, grid trays and tote boxes is described in bulletin offered by Kerlow Steel Flooring Company. Also given are dimensions of each design of grating and safety step and a safe load table.

For copies write Kerlow Steel Flooring Company, Department 35, 21 Mallory Avenue, Jersey City 5, N. J.

Heaters and Exchangers (Item 314)

Catalog 202 of Patterson-Kelly Company, Inc., gives typical piping arrangement, instruction for selections, and table of dimensions of the company's hot water heater line. Also included are capacities tabulated in gallons per hour for 0, 2, 5, 10, 15, 25, 35, 50, 75 and 100 pounds steam. Pressure loss table condensate and coolers; condensate cooler; and gravity flow and booster heaters are also explained.

For a copy write The Patterson-Kelly Company, Inc., 18 Wilson Avenue, East Stroudsburg, Pa.

MIDGET **YEL O BAK**

THERMOMETER

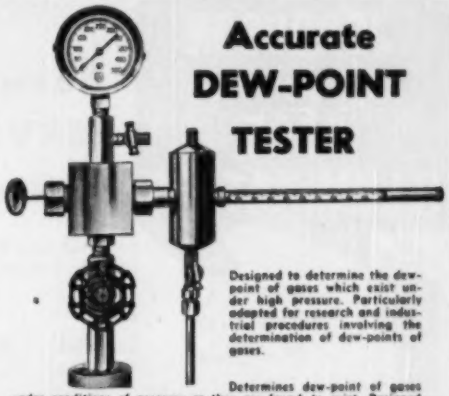
Flat Bore Mercury Filled
Engraved Stem

Recommended for installation on oil, gasoline and water lines; tanks, stills or any place requiring a small armored thermometer and where large industrial thermometers are not conveniently applicable. Gives 50% Better Visibility.

STRAIGHT OR ANGLE STEMS
Four Temperature Ranges Available

Special Sizes and Ranges made to your specifications and requirements.

Write for **YEL-O-BAK** *Bulletin*



Accurate DEW-POINT TESTER

Designed to determine the dew-point of gases which exist under high pressure. Particularly adapted for research and industrial procedures involving the determination of dew-points of gases.

Determines dew-point of gases under conditions of pressure as they are found to exist. Designed primarily for use in connection with high pressure gas transmission lines. Standard Range 0 to 600 p.s.i. High Pressure Range 0 to 2,500 p.s.i.

Write for Catalog 50—Complete Line of Scientific Laboratory Equipment

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INSTRUMENT ENGINEERS AND MANUFACTURERS

REFINERY SUPPLY COMPANY

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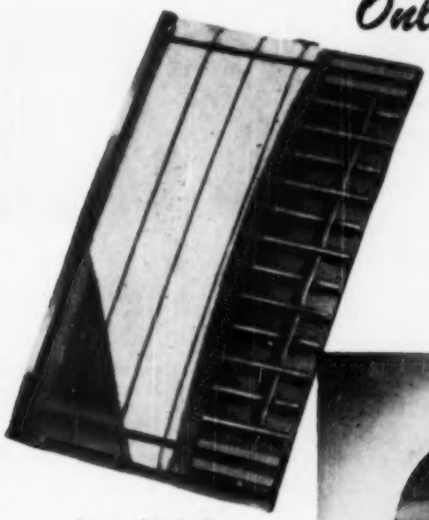
Only GB **FILTERS** *have "It"*

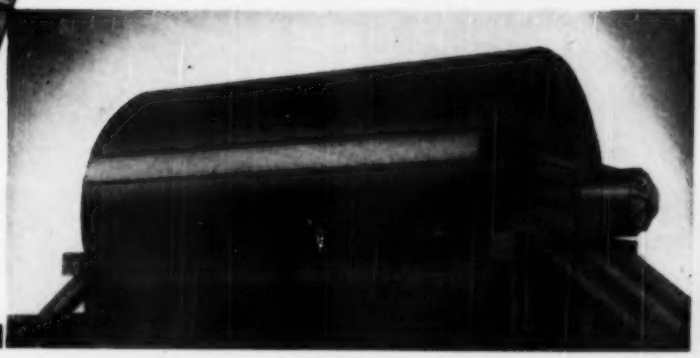


"It" is the G-B patented drum compartment drainage shown in the close-up at left. From the rugged, precision machined division bars to the die-formed wire and locking strips, G-B drainage was designed to provide

1. **Smooth, uniform support for maximum cloth life**
2. **Easy cloth replacement and drainage screen renewal**

These features help you obtain

LOW MAINTENANCE COST
GREATER TIME ON STREAM



For complete details on G-B Filters, write

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MANUFACTURING COMPANY, Inc.
Birmingham, Alabama
350 Madison Ave., New York

JERGUSON
Explosion-Proof
GAGE ILLUMINATORS

Give Even, No-Glare Low Cost Lighting Greater Safety Of Operation Faster, Easier Gage Reading

JERGUSON Explosion-Proof Gage Illuminators give you the best, lowest cost, most efficient gage lighting.

Utilizing the principle of solid wedge lighting, Jerguson Illuminators give clear, *even* lighting, without bright spots. Light flows through the plastic wedge and is reflected evenly through the back of the gage glass to give quick, easy, accurate reading. You get better illumination at lower cost because only one small lamp is required. Savings in electricity soon pay for the illuminator.

Jerguson Illuminators have aluminum explosion-proof housing for the wiring and heat resisting glass explosion-proof housing for the lamp. You get maximum safety, more efficient lighting with Jerguson. Made for all sizes of transparent gages. It will pay you to investigate.

Illustration shows single and double Jerguson Illuminators on a 3-section gage. Write today for full information. Ask also for Data Units on Jerguson Gages and Valves to fit your needs.

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JERGUSON GAGE & VALVE COMPANY
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About EQUIPMENT and SERVICE Suppliers

Steel and Oil Industrialists Buy Vulcan Steel Tank Firm

Charles A. McNamar is new president of The Vulcan Steel Tank Corporation,

McNamar

McKelvey

Tulsa, which he purchased jointly with Lawrence N. McKelvey and A. W. (Tony) Crowley. Vulcan will continue to design and build refinery, gasoline and chemical plant vessels, but in addition, will expand facilities to serve the production, pipe line, chemical and marketing fields of the industry. The corporation was established in Tulsa over 28 years ago. Present officers represent the third and fourth generation in the steel business.

Crowley

McNamar will direct sales and development of the new products. He was formerly employed with his father in the manufacture of the McNamar drilling boiler. Later the two founded the McNamar Boiler and Tank Company which was sold in 1945.

McKelvey is executive vice president and general manager of Vulcan. He has been with Vulcan Steel Tank since 1927. Previously he was associated with Pioneer Tank and Boiler Company and Brier Hill Steel Company which is now Youngstown Sheet and Tube Company.

Crowley as vice president of the company will direct sales in the Illinois basin. Crowley is also president of McNamar and Crowley, Inc., at Salem. He has been city representative with Republic Supply Company and Bethlehem Supply Company.

Considine Gets Promotion

Douglas M. Considine has been appointed manager of the market extension division, general sales, of Brown Instruments division of the Minneapolis-Honeywell Regulator Company. Considine's new duties will include direction of advertising and technical and trade editorial activities. He will continue as technical editor of "Instrumentation," Brown's house-trade publication.

Considine is a graduate of Case Institute of Technology and holds a bachelor's degree in chemical engineering. He has been with the company since 1941.

Metal Goods Named Agent For Childers Jacketing

Metal Goods Corporation has been appointed the exclusive distributor of Childers Manufacturing Company aluminum weather-proof jacketing in the Mid-West and Southeast. The finished jacketing is packaged in 100-foot rolls for use over moulded pipe insulation. It can be attached by aluminum bands, special plastic tape or sheet metal screws.

Metal Goods offices and warehouses are located in St. Louis, Houston, New Orleans, Dallas, Denver, Kansas City, and Tulsa.

Named Vice President Of Tulsa Western Supply

James E. Hughes has been elected vice president of Western Supply Company of Tulsa. He joined the firm in 1946, helping to develop the heat exchanger department. Previously he was associated with Phillips Petroleum Company in the engineering department and in licensing Phillips patent structure.

Hughes

The company, in addition to its main office and plant in Tulsa, has sales offices in Houston and is represented in San Francisco by Trident Engineering Company. Western is a member of the Tubular Exchanger Manufacturing Association.

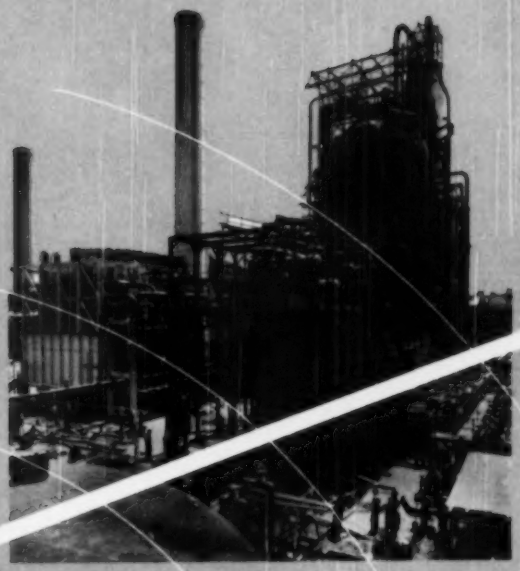
Iverson Opens New Houston Office

Iverson Supply Company is now occupying a new Houston location, according to R. B. (Bob) Yanaway, division manager in the Gulf Coast office.

The company has other facilities in Tulsa, Okmulgee, Oklahoma City; Salem, Ill., Artesia, N. M., Kermit, Odessa, and Snyder, Texas.

Rockwell Supervisor Named

Lee Snodgrass has been appointed Pacific coast supervisor of the gasoline and oil meter division of Rockwell Manufacturing Company. He will supervise all sales and service of the oil meters and accessories manufactured by Rockwell for the production, refinery and marketing divisions of the oil in-



The Refiner

Foster Wheeler

construction

fabrication

engineering

design

dual control

active liaison between the Refiner and Foster Wheeler in the office, shop and field; . . .

complete agreement on every detail in the design, engineering, fabrication and construction sequence; . . .

a combined experience that can straighten out unscheduled situations . . .

These are the essential components which provide an accurate and overall dual control which saves time, saves money, and creates another satisfied Foster Wheeler customer.

FOSTER WHEELER CORPORATION

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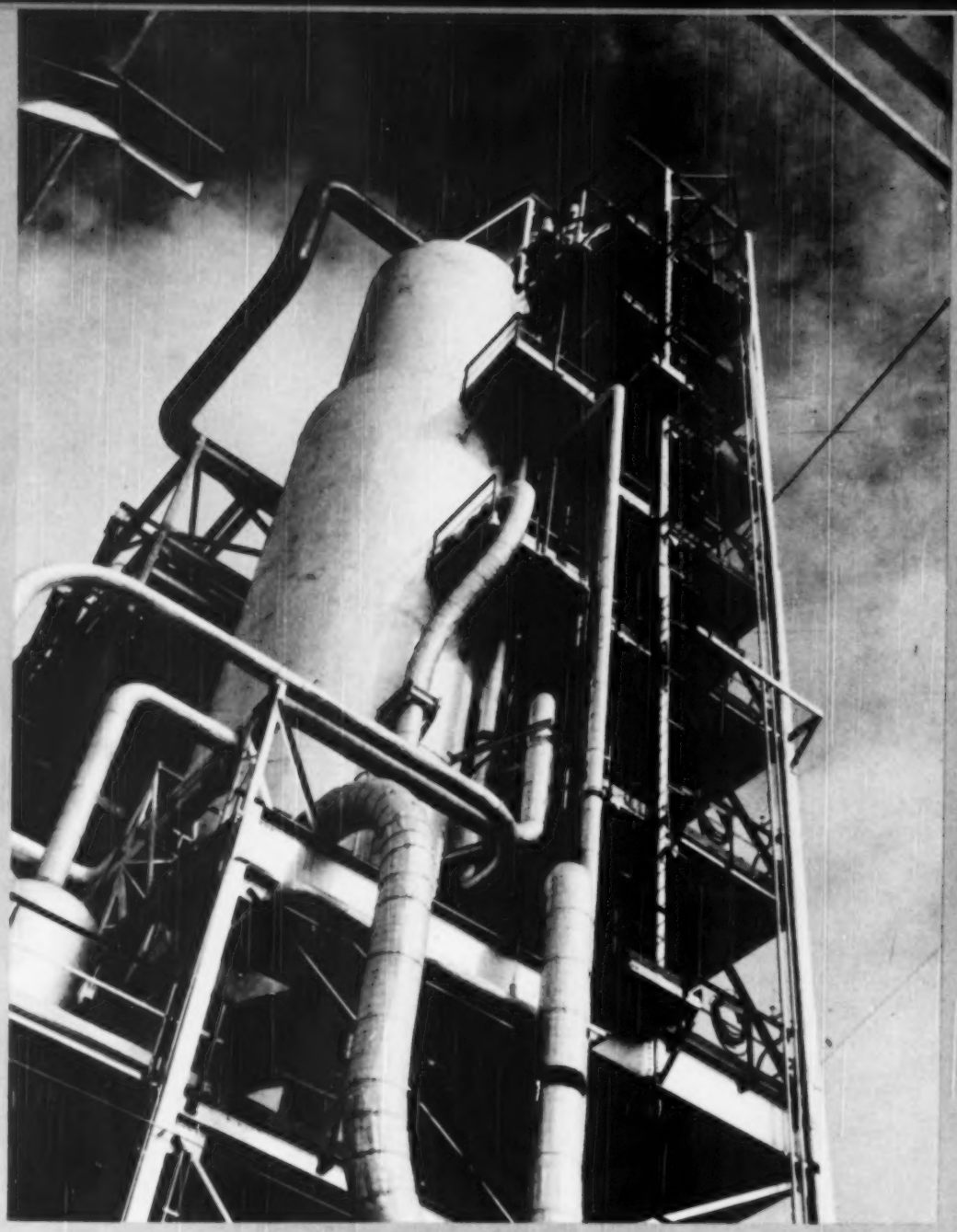
the complete engineering and construction service anywhere in the world



63,000 bbls/day

A top-of-column view of the 63,000 bbl/day Crude Distillation Unit engineered and constructed by Foster Wheeler for the Creole Petroleum Corporation at Amway Bay, Venezuela.

FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK

dustry on the Pacific coast.

Snodgrass first joined Rockwell in 1941 with the valve division. For the past few years he has been specializing in oil and gasoline meter sales.

Worthington Announces Four Executive Promotions

Worthington Pump and Machinery Corporation, Harrison, N. J., has appointed Walther H. Feldmann, vice president in charge of sales; John J. Summersby vice president in charge of purchases; Frederic W. Thomas, general manager of purchases; and Carleton Reynell, general representative, sales and purchasing departments.

Feldmann recently resigned as president of a subsidiary, Electric Machinery Manufacturing Company, Minneapolis, which he joined in 1922. Other positions he has held are district manager, general sales manager, vice president and general manager. He will be headquartered at the Harrison offices.

Graver Water Florida Agent

Newly named Florida representative for Graver Water Conditioning Company is Tom Charbonneau. Charbonneau has been engaged in water conditioning problems in the southeastern states since completion of engineering courses at the Universities of Connecticut and Pennsylvania and special courses on water conditioning at the University of Florida. For some years he has been employed in sales and supervising work on treatment of boiler feedwater, consulting work on waste recovery, and municipal water plants. His headquarters will be at Orlando.

Du Pont Announces Changes In Petrochem Division

David H. Conklin and E. Hearn Simpson have been appointed sales managers

Wirth III

Conklin

Towery

Simpson

of the petroleum chemicals division, E. I. du Pont de Nemours and Company, Inc., Wilmington, Del. Simpson is to head industrial sales, and Conklin to direct sales promotion. Both were previously sales managers of the division.

The eastern district is represented by Charles Wirth III with headquarters in New York. Charles D. Towery, formerly service representative in the Gulf Coast district, is Mid-Continent district manager at Tulsa, succeeding Wirth. Wirth graduated from Tulane University with a M.S. degree in organic chemistry. He served with Gulf Oil Corporation and Universal Oil Products Company prior to joining du Pont. At Tulsa in 1947, he organized the office and petroleum service laboratories. Towery is a graduate of Texas A. & M. and has worked with Gulf Oil Corporation, The Pure Oil Company, and Bethlehem Supply Company before joining du Pont in 1947.

Other appointments at Wilmington include Joseph L. Stecher, formerly manager of petrochemicals production, as assistant sales director of the division, and Emory M. Fanning, as assistant sales director of Kinetic Chemicals, Inc., manufacturer of "Freon" fluorinated compounds for the refrigeration, air-conditioning, and aerosol industries. He was formerly petrochemicals sales manager.

Thomson Firm Chiksan Agent

Appointment of George S. Thomson Company, Phoenix, Ariz., as representative for the state of Arizona is announced by Chiksan Company, Brea, Calif.

Link-Belt Opens Warehouse

Link-Belt Company has announced opening of a factory branch store and warehouse in Kansas City, Mo., at 2680 Holmes Street, in a two-story building.

Federated first for Lead Products

Asarco Sheet Lead... All commercial weights and sizes. Chemical...Tellurium Chemical...Antimonial.

Asarco Lead Pipe... All commercial sizes. Special sizes on request. Chemical...Tellurium Chemical...Antimonial.

Asarco Lead and Lead Lined Valves ... Split Type "Y" and "Angle", Standard "Y", Gate, Check, Hard Lead "Y", Plug and Seat.

Asarco Lead Fittings... Elbows, Crosses, Tees, "Y's", (with plain ends, with flanges on, or for flanging in the field). Chemical and Antimonial.

Asarco Lead Wool... 3/8" rope in 50 lb. waterproof bags.

Asarco Lead Specialties... Extrusions and Castings to specification.

See Federated also for Lead Lined Pipe Lead Lined Fittings, Lead Lined Flanges

Federated Metals Division
AMERICAN SMELTING AND REFINING COMPANY
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KERLOW
KERLOW GRATINGS
For Every Industrial and Traffic Service
Come to Kerlow for every type of open steel grating for any purpose. Kerlow products include grid trays, walkways, floors, platforms, safety steps, tote boxes, pallets, drain grates, trench covers, bridge flooring, slabs and armoring. Light but strong and durable; self-clearing and fully ventilating, easy and economical to install and maintain.
Write for Catalogs on types of grating in which you are interested.
KERLOW STEEL FLOORING CO.
25 Mallory Ave., Jersey City 5, N. J.
KERLOW
OPEN STEEL FLOORING

with a total floor area of 13,200 square feet. Stocks of conveying and power transmission machinery parts, chains, sprockets, bearings, speed reducers and elevator buckets will be carried. Arthur J. Olson is district manager.

New Manager of Diamond Plant

John W. Mantz, for the past two years industrial relations manager at the Painesville, Ohio, plant of Diamond Alkali Company, has been promoted to the newly-created position of assistant general manager of the plant. Mantz will be succeeded as industrial relations manager by C. R. Brown, who comes to Diamond from National Enameling and Stamping Company, Milwaukee, Wis., where he was director of industrial relations.

Chicago Selas Manager

Anthony J. Potts has been appointed Chicago district manager of Selas Corporation of America, heat processing engineers.

Potts

Before, Potts was in the Selas main office and plant in Philadelphia. Prior to joining Selas staff, he represented George J. Meyer Manufacturing Company. Earlier, he was with the Brown Instrument division, Minneapolis-Honeywell Regulator Company.

Selas maintains a Chicago office at 3857 West Washington Boulevard.

Heads Pacific Pumps Sales In Mid-Continent Area

Pacific Pumps, Inc., Huntington Park, Calif., has appointed A. F. Canada manager of centrifugal pump sales for the mid-continent area with headquarters in Tulsa. Other appointments include D. W. Conkling and A. L. Anheier, centrifugal pump sales engineers, Tulsa; and W. L. Wathen, centrifugal pump sales engineer, Houston. W. R. Carlsen will continue as Houston district sales manager.

Canada joined Pacific in 1945 as Tulsa district manager. In his new position he will direct the sales of centrifugal pumps in the Rocky Mountain, Mid-Continent, and Gulf Coast territories.

Adams Is Kerotest District Manager

E. T. Adams has been appointed district manager of oil country valve sales in the Houston sales territory by Kerotest Manufacturing Company. Adams was previously director of purchases and head of production control at Kerotest's home offices in Pittsburgh.

Adams

Formerly with several oil companies in South America, Adams joined Kerotest Manufacturing Company in 1945 as a steel valve salesman in the Houston territory.

S. A. Clarke, Jr., has been named the new Kerotest purchasing agent.

Combustion Engineering Names Two New York Executives

H. G. Ebdon and William P. E. Ainsworth have been elected vice presidents of Combustion Engineering—Superheater, Inc., New York.

Ebdon joined the company in 1917 and since 1925 has served successively as manager of the Proposition Department; sales engineer, New York; assistant general sales manager; and general sales manager of boilers and related equipment. He will continue in the latter capacity, working in association with Donald S. Walker, the company's vice president and director of sales.

Ainsworth began with the company in 1921 as a service engineer and later became manager of the service and erection department. Successively he has been general purchasing agent and production manager. As a vice president he will continue in charge of purchasing and production for the company's six American manufacturing plants.

Becomes New ACF Secretary

C. Allan Fee has been elected secretary of American Car and Foundry Company, succeeding Howard C. Wick who is retiring after 45 years of service, the last 34 as secretary.

Fee, who entered the employment of ACF in 1915, formerly was assistant secretary.

New Manufacturing Division

Process Industries Engineers, Inc., of Pittsburgh announces the formation of

Over many years of service

HAERING ORGANIC GLUCOSATES*

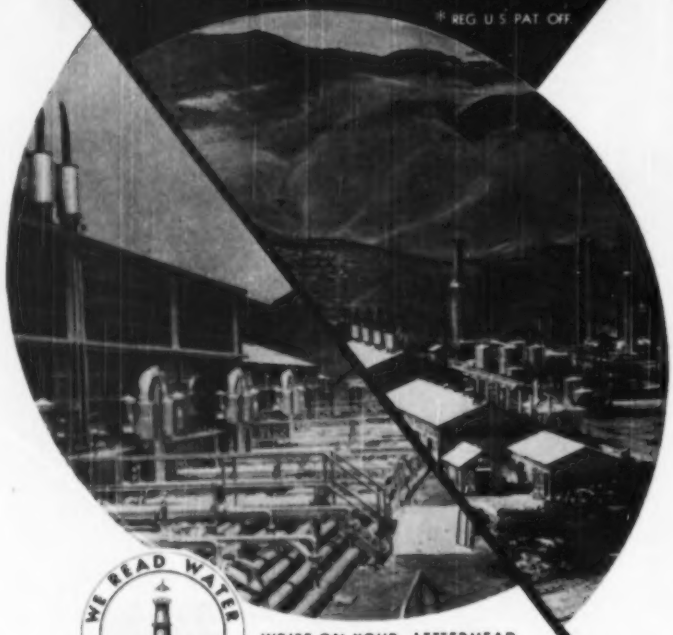
have an unexcelled record of performance in controlling

SCALE, CORROSION AND ALGAE

in the

PETROLEUM INDUSTRY

* REG U S PAT OFF



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D. W. HAERING & CO., Inc.

Established 1931

General Offices P. O. Box 6037 San Antonio, Texas

Chicago Office, 205 West Wacker Drive

ideal for High-Temperature Bolting

because of its BUILT-IN STRENGTH

You can count on long, satisfactory service when you use the Bethlehem Quenched Nut in the high-temperature, high-pressure bolting applications encountered in refineries.

The Bethlehem Quenched Nut is ideal for use in severe bolting applications because of its built-in strength. This nut is no ordinary nut, punched from a hot bar. Instead, it is *hot-forged*—actually formed by forging and extruding hot metal into a forming die. This is followed by quenching and tempering, which produces a nut strong enough to break any stud or bolt on which it is used.

The Bethlehem Quenched Nut has a tough grain structure, and its oxidized sides are resistant to atmospheric corrosion. The nut also has a bearing surface which is far superior to common, machined surfaces.

The Quenched Nut is manufactured at Bethlehem's Lebanon, Pa., plant, and conforms to Grade 2H of ASTM Specification A194. It is carried in stock in bolt sizes from ⅜ in. to 3½ in. Lebanon Plant also stocks nuts in Grades 0, 1, 2, and 4. If you'd like one of our representatives to explain in greater detail the advantages of the Quenched Nut, contact our nearest sales office, or write to us at Bethlehem, Pa.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

Export Distributor: Bethlehem Steel Export Corporation

Bethlehem supplies every type of Fastening

GEAREX
ROTARY PUMPS
move more— for less!

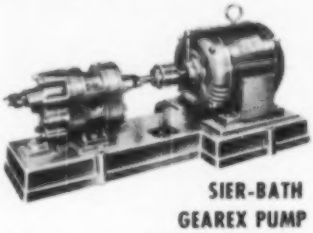
Only 2 Moving Parts!

Rotating Element of GEAREX Pump

Photo shows the "heart" of a Gearex Pump. It provides **more displacement** per revolution because rotors do not transmit power—are designed to fulfill just **one** function: moving material. It means **less maintenance** because (1) rotors never touch metal (2) proper rotor clearance is accurately maintained by Sier-Bath **precision cut** timing gears.

ADDITIONAL ADVANTAGES

- Pulseless flow
- Vibrationless operation
- Low pressure on stuffing boxes
- Direct connected up to 1800 RPM
- Available in corrosion resistant alloys
- Horizontal or vertical construction



SIER-BATH GEAREX PUMP

Two general types: **INTERNAL BEARING TYPE** (above) for lubricating liquids, **EXTERNAL BEARING TYPE** for non-lubricating liquids. Capacities: 1-550 GPM. Discharge: 250 PSI for viscous liquids, 50 PSI for water. **SIER-BATH SCREW PUMPS** for higher pressures and capacities.

Write for Booklet

FOUNDED 1901 MEMBER A.O.M.A.

Sier-Bath GEAR and PUMP CO., Inc.

9211 HUDSON BOULEVARD NORTH BERGEN, NEW JERSEY

a manufacturing division to accommodate the demands for fabrication of specially engineered equipment for the chemical, petroleum, food and allied industries. The company will continue operations of the engineering and sales divisions at their present location at 5941 Baum Boulevard.

Will Handle Valve Lines Of Rockwell Alabama Sales

W. O. Brady has been appointed to the sales force of Rockwell Manufacturing Company. Brady will cover the state of Alabama and handle the meter, regulator and valve lines of the Pittsburgh Equitable Meter and Nordstrom Valve divisions of Rockwell, according to an announcement by J. W. Northcutt, district manager, Atlanta territory.

Brady

Since 1939, Brady has been employed by the United Gas Corporation at Gulfport, Miss.

The company's headquarters at Pittsburgh are located at 400 North Lexington Avenue.

Canadian Headquarters For Tube Turns Manager

Arthur H. Brodie, in his recent appointment as district manager, Tube Turns, Inc., of Canada Limited, will have headquarters at the plant in Chatham, Ontario. Brodie will make his home in Montreal where he was born and went to technical school.

Brodie

Brodie was associated with International Equipment Company, Toronto, before joining Tube Turns March 16.

Tube Turns, manufacturer of welding fittings and flanges, and custom forgings, has U. S. offices in Louisville, Ky.

Hagan Names Two Managers For Los Angeles Locale

Gordon S. Schuhmacher has been appointed district manager in Los Angeles for Hagan Corporation, Pittsburgh, and its subsidiaries, Calgon, Inc., Hall Laboratories, Inc., and The Buromin Company. He succeeds R. L. Sullivan, resigned.

Schuhmacher, who will be assisted by Joseph R. Shafer, joined Hagan in 1942.

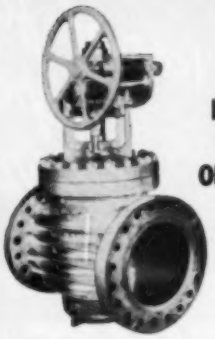
Shafer joined Hagan in 1941, as a service engineer.

Directs Vat Dye Research

Dr. William B. Hardy has been appointed a sectional director in charge of the entire research program in the field of vat dyes of the chemical research department, American Cyanamid Company, Calco Chemical Division. Dr. Hardy holds B.S. and Ph.D. degrees from the University of Chicago.

Recent additions to the manufactur-

WEDGEPLUG
ALL-PURPOSE
STEEL VALVES



LIFTS TURNS and RE-SEATS IN ONE OPERATION

☆

DRY PLUG

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PRICED to compete with conventional plug-type valves. Interchangeable with American Standard Steel Wedge Gate Valves. Wrench-Operated; Direct Handwheel-Operated; Worm Gear-Operated; Sizes from 1" to 16". Write for our Catalog No. 600 and Price List. On request, we will be glad to quote on larger sizes above 16".

WEDGEPLUG VALVE CO., INC.

Department "R"

NEW ORLEANS 15, U. S. A.

industrial
OIL AND GAS BURNING EQUIPMENT

- Mechanical Atomizing Oil Burners
- Steam Atomizing Oil Burners
- Refractory Burner and Muffle Blocks
- Industrial Gas Burners
- Low Air Pressure Oil Burners
- Fuel Oil Pump Sets
- Valves, Strainers, Furnace Windows
- Tandem Block Combustion Units
- Combination Gas and Oil Burners

Detailed information gladly sent you upon request.

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NATIONAL AIROIL BURNER COMPANY INC.

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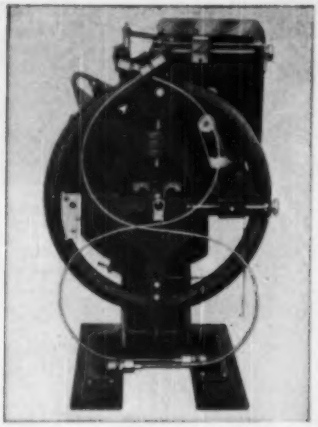
Southwestern Division:
2512 South Boulevard, Houston 6, Texas



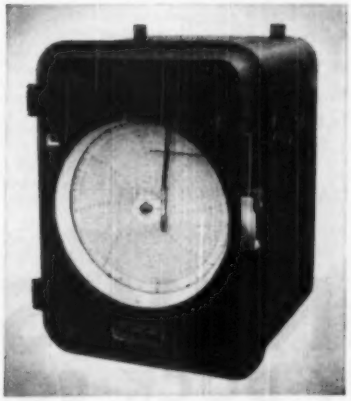
Rear View of Hagan Ring Balance Meter with single high-differential ring. Integrator is at upper right.

Same orifice . . .
same meter body . . .
full scale differential
continuously adjustable from
20 to 140 inches

with HAGAN

RING BALANCE METERS

Hagan Dual Meter with two low differential rings. Integrator can be provided for each ring if desired.



Dual Meter case occupies same panel space, and is only 5 inches deeper than single-ring case.

The Hagan Ring Balance Flow Meter is not a "fixed-head" meter but can be adjusted to accommodate a change of as much as 7 to 1 in maximum head—with full scale chart reading.

This is accomplished by a spring resistance system which is adjusted by a simple range screw. Especially at low flows, this system gives high accuracy in the conversion of differential head to pen movement.

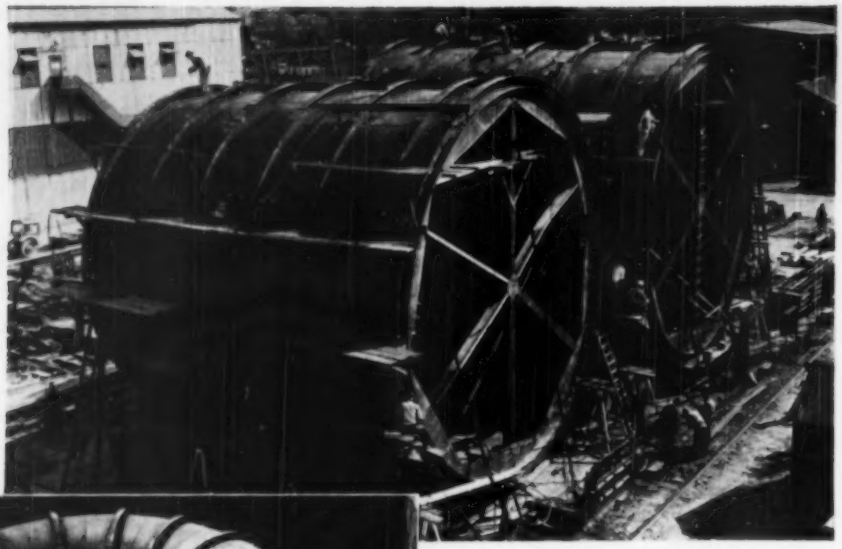
Other models of this meter are available for heads of two inches or lower, and up to 420 inches — and each has this same easy adjustability.

For full information on these meters, or on any application in which you are interested, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS



TO HARNESS THE ELEMENTS

Shown are shop erections of sections of a wind tunnel and a water turbine spiral casing at Newport News. One to be used in the development of America's planes of the future, the other to generate power in the world's largest hydro-electric development.

Tolerances required for the 34-foot diameter welded structure of the wind tunnel were: flushness or smoothness plus or minus 0.01″; fairness of structure 0.03″ and up to 1/32″ in diameter.

Eighteen of the 165,000 horsepower turbines at Grand Coulee have been built by Newport News. Nine sections of the casings are cast steel and six are welded and cast. These turbine units are the most powerful ever built.

Refractory towers, pressure vessels, bridge cassions and other heavy equipment of special design are fabricated at Newport News. The plant, over a mile in length, includes welding and steel fabricating shops, machine shops, foundries and forge shop to provide the advantages of building the complete job.

"Facilities and Products" catalog will be sent if requested.

BUILDERS OF EQUIPMENT FOR CHEMICAL, PETROLEUM AND PETRO-CHEMICAL INDUSTRIES

NEWPORT NEWS
SHIPBUILDING AND DRY DOCK CO.
NEWPORT NEWS, VIRGINIA

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RATES for Classified Ads are $8 per column inch. Minimum size one column inch. In smallest type size, figure 50 words per inch. **Situations Wanted $4 per column inch. All classified ads payable in advance.** Ten percent discount if three or more insertions are ordered at same time. COPY DEADLINE is 25th of month preceding date of issue. Send copy and checks to: Classified Ad Department, Petroleum Refiner, P. O. Box 2608, Houston 1, Texas.

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'Supplement Your Present Income'
Nationally known organization, desires reliable representative in Houston area to accommodate large research laboratories with a complete line of custom blown glassware. Must have excellent character. Commissions will afford a liberal and dependable income to this man or woman. Box 169-R, Petroleum Refiner, Houston, Texas.

HELP WANTED

Instrument Engineer

Graduate engineer with several years experience in the selection of automatic control instruments for petroleum processing plants required by engineering and construction company operating internationally. Initially for service in New York Office. Box 171-R, Petroleum Refiner, Houston, Texas.

ESTIMATOR

Experienced ENGINEER, familiar with Oil Refinery design and capable of estimating process equipment from flow diagrams. Give full information, experience record and salary expected.

ARTHUR G. McKEE & CO.
2300 Chester Ave.
Cleveland 1, Ohio

ing department include H. M. Carleton, P. B. Sheridan, W. H. McCammon, R. L. Kelley, G. L. Smith, and M. Papier.

Named Fluor Ad Director

Harold J. Bordelon has been promoted to advertising supervisor of The Fluor Corporation, Ltd., Los Angeles. Formerly assistant advertising manager, he succeeds Jack E. McKay, recently named to the Houston sales office as sales engineer.

Bordelon

Bordelon who has been with the company eight years, was instrumental in organizing Fluor-o-Scope, the employe magazine. He first began as draftsman in the Kansas City office and was transferred to the advertising department at Los Angeles in 1944. For the past two years, Bordelon has been publicity chairman for the California Natural Gasoline Association.

Kaylo Moves Office to Houston

The Kaylo Division, Owens-Illinois Glass Company, manufacturer of heat insulating and structural calcium-silicate material, has announced the transfer of its Dallas branch to Houston and the appointment of J. K. Dixon as sales engineer for the Houston territory. Dixon's territories comprise the Gulf Coast east to Florida, the state of Louisiana, and Texas as far north as Waco and San Angelo.

T. F. Sears, former Dallas branch sales engineer, has been promoted to the general office in Toledo, Ohio, as supervisor of roof tile sales for the Kaylo Division.

Edward Valves Adds to New East Chicago Labs

The new physical, chemical and metallurgical laboratories of Edward Valves, Inc., formerly opened less than a year ago at East Chicago, Ind., are being increased nearly 50 percent in size with the construction of a new unit for which ground recently was broken. Essentially all the new expansion will be devoted to testing valves and piping under fluid flow. Test boilers, compressors, pumps and other equipment will permit the uses of gases and liquids at pressures up to 5000 pounds and temperatures up to 1500°.

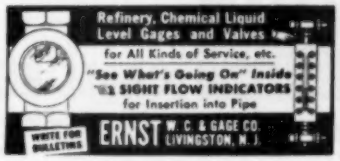
Fischer & Porter Course Is Scheduled for July

July 10 and 14 mark the beginning and the end of the third quarterly instrumentation course for 1950 at the Hatboro, Pa., plant of Fischer & Porter Company. Manufacture, calibration, installation, operation and maintenance of flow (variable area and orifice), liquid level, specific gravity and viscosity instruments will be covered.

U. S. Testing in New Offices

United States Testing Company, Inc., announces the moving of its New York offices to the McGraw-Hill Building, 330 West 42nd Street. New manager will be Thomas C. Ridgway of the service division.

One of the largest and oldest independent commercial testing and research organizations, the firm has its main laboratories and offices at Hoboken, N. J., and eight other branches throughout the country. Its New York office has heretofore been located at 1450 Broadway.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for Insertion into Pipe
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ESPECIALLY RECOMMENDED FOR USE IN THE

COPPER SWEETENING PROCESS

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COPPER SULPHATE

is preferred by leading refineries because of its high copper content, dependable uniformity and exceptional purity and freedom from foreign and inert matter.

99% + PURE

Quotations on request, on any quantity required. Shipments can be made from our nearest plant.

PHELPS DODGE REFINING CORP.

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strapping and seals

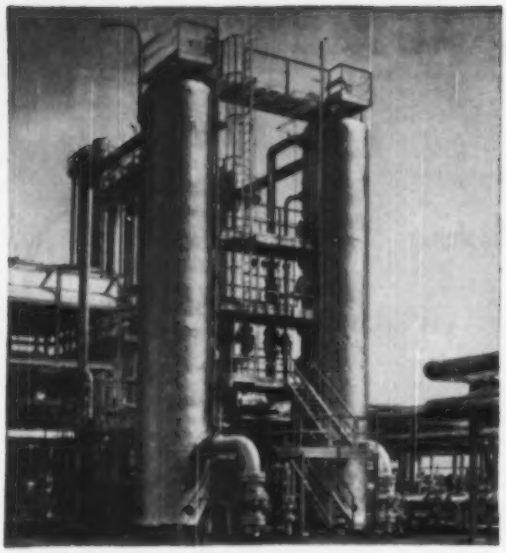
Our specialized service will supply just what you need for securing insulation to forms, pipe lines and tanks. Strapping and Seals produced in

MONEL
STAINLESS, TYPES 304, 316
ALUMINUM
COPPER
BRASS
GALVANIZED

Strapping Tools for applying.

FREE
Handy calculator—one side tells you which strap to use for any given corrosive condition; other side determines length and weight of strap required for any binding operation.

A. J. Gerrard & Co.
1936 Hawthorne Ct., Melrose Park, Ill.
(Chicago Suburb)
SM-2



Panoma has found

FLORITE

"very satisfactory"

The Panoma Plant of the Panoma Corporation, near Hooker, Okla., uses Florite in its dehydration towers, which were handling daily at last report, 85 million standard cubic feet of natural gas at a pressure of 675 pounds. They were designed to handle 140 million standard cubic feet at 750 pounds pressure. Gas dehydration is required in preparation for pipeline transmission.

This large modern plant has been in use since November, 1948, and, according to a report of the Panoma management at the end of a year, "has operated very satisfactorily."

Floridin Products, adapted to a wide range of industrial and technical uses, include especially prepared forms of

FULLERS EARTH

as well as two grades of Florite, which is a . . . .

BAUXITE-BASED ADSORBENT

Your inquiry will be given careful attention.

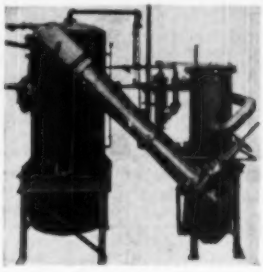
FLORIDIN COMPANY

Adsorbents . . . Desiccants . . . Diluents

Department E, 220 Liberty St., Warren, Pa.

WHAT WILL SUMMER HOT WEATHER DO TO YOUR PROCESS

Croll-Reynolds CHILL-VACTORS frequently show a good profit over the total cost in extra production the first season, and they have many years of maintenance-free service. There are usually extra benefits in better quality and more uniform quality.



CHILL-VACTORS have many advantages, but are not perfect. In general, they are limited to temperatures above 32°F. They require more condenser water than mechanical refrigeration, but almost any natural water, including sea water, can be used. There are too many advantages to list here. The most important are:

Low cost

Can be operated by low pressure steam

No refrigerant except water

No moving parts, noise or vibration

Practically no operating supervision

Some liquids or solids can be cooled direct without brine or other circulating fluid.

Made in sizes from a few tons to 1,000 tons or more (1 ton = 12,000 B.T.U. per hour)

Individual engineering study will be given without obligation to each inquiry. This also applies to any industrial vacuum requirement down to a few microns absolute pressure.

CROLL C R REYNOLDS

CROLL-REYNOLDS CO., INC.

17 JOHN STREET, NEW YORK 7, N. Y.

Chill Vactors **Steam Jet Evactors** **Condensing Equipment**

For complete selection...Better service ...Get everything from CRANE

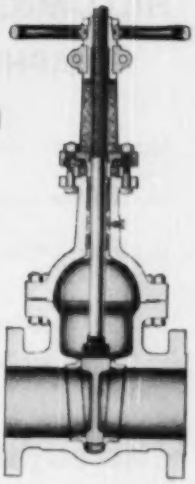
STEEL VALVES FOR LONG SERVICE...EASY OPERATION

No matter how tough or how precise your service requirements... Crane Cast Steel Wedge Gates will meet them. Crane Quality construction assures highest resistance to pipe line strains, pressure variations, and extreme changes in temperature.

These valves are as easy to operate as they are to keep at peak efficiency. Closely-guided solid wedge disc seats accurately and smoothly; prevents drag and wear on seating surfaces. Side strain on stem is eliminated by Crane flexible T-head and disc-stem connection. Ball-type gland maintains even pressure on packing, avoids binding on stem.

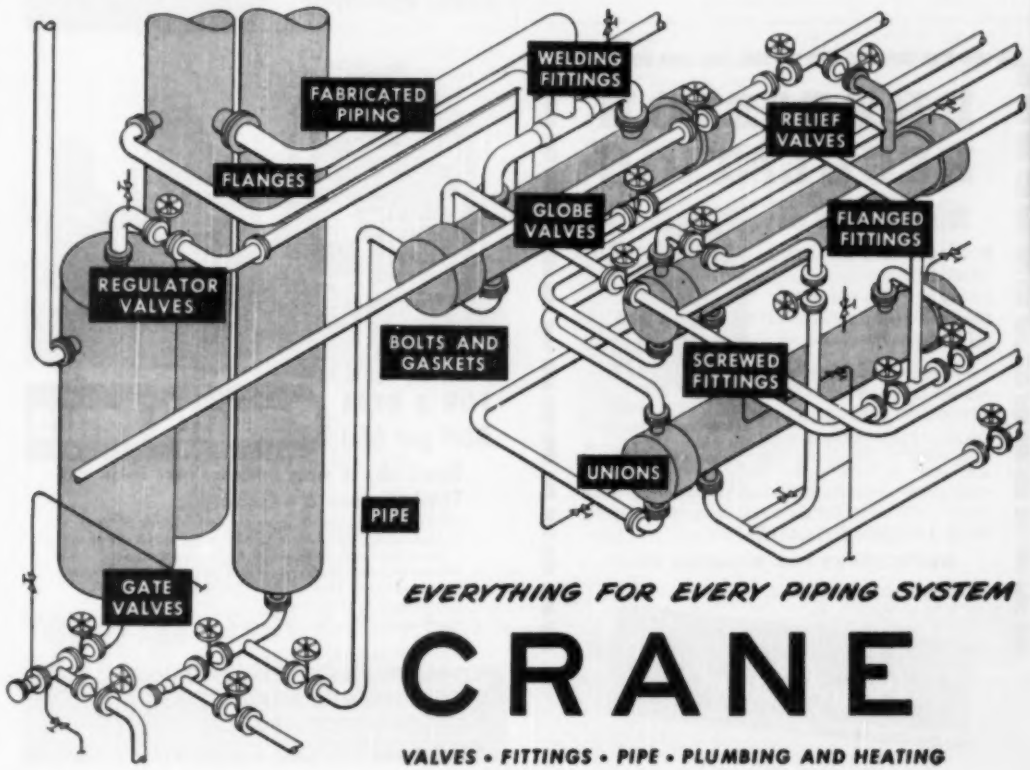
Choose Crane Cast Steel Gates for dependable service. Regularly available in pressure classes up to 1500 pounds, for temperatures up to 1100° F. See your No. 49 Crane Catalog.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas



No. 33X, 300-Pound Steel Gate. For oil and oil vapor up to 1100° F. Exalloy to Exalloy seating. Sizes: 1½ to 24 inches.

ONE ORDER TO CRANE EQUIPS THIS VAPOR RECOVERY PROCESS UNIT, FOR EXAMPLE



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HILLS-McCANNA DIAPHRAGM VALVES

have the best record for trouble free service and low maintenance cost. Available in all sizes from ½" to 14" inclusive.

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Mid-Continent and Gulf Coast Representative

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Modern petroleum processing methods

Here is a guidebook for plant managers, superintendents, chemists, engineers, and other refinery men—providing a complete, modern treatment of petroleum processing. It emphasizes the relation of refining to chemical engineering, covering fundamentals, many details of the design and operation of petroleum equipment, economical aspects, etc.

JUST OUT!

Petroleum Refinery Engineering

By W. L. Nelson, Professor of Petroleum Refining, University of Tulsa; Consulting Petroleum and Chemical Engineer. 3rd Edition. 715 pages, 6 x 9. **106 tables. 201 illustrations** **$9.00**

It provides a complete background of engineering theory in chapters on chemistry, laboratory evaluation methods, the physical properties of oil, and the unit operations of chemical engineering as applied to petroleum—as well as chapters that deal particularly with petroleum refining.

Illustrations or examples of almost all important calculations are included. The book builds up a few very important fundamentals and indicates how these may be used to work almost any type of plant problem, even those not directly associated with petroleum.

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Within .005 psi

FOR MANUAL LOADING SERVICE...for remote positioning . . . for accurate flow meter calibration, our MODEL H-10 is tops in the field.

It's built especially for dead end (no flow) service . . . and guaranteed to be free from "drift" errors. Ranges 0-5; 0-25; 0-50; 0-125 psi for inlet pressures to 150 psi.

If you are looking for a pneumatic regulator that is sensitive to .005 psi (in 0-5 psi range), stable and foolproof, **HERE'S YOUR REGULATOR.**

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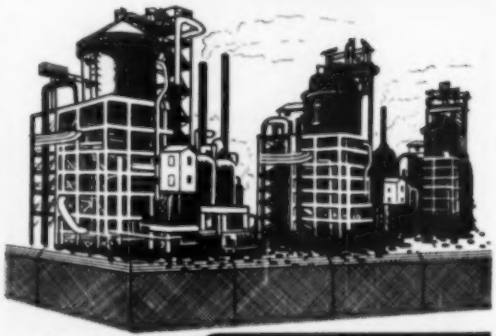

FOR A REAL BUY get CF&I Realock Fence

Here's why so many refineries have found that REALOCK® Fence is a REAL buy:

- first cost is moderate
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FOR A *REAL BUY*, BUY *REALOCK*

Realock fence CF&I

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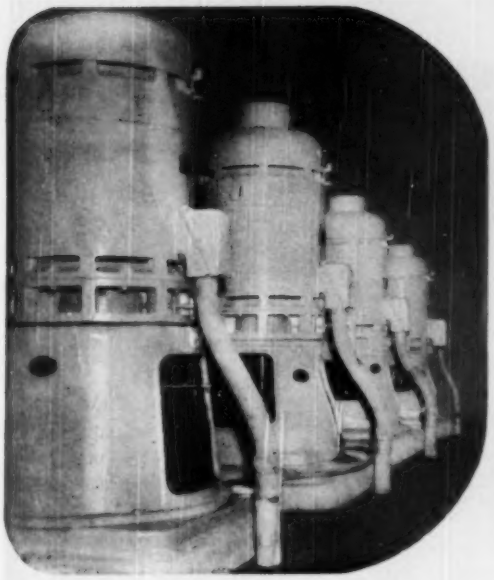
General Offices: Denver, Colorado

Pacific Coast Sales: The California Wire Cloth Corporation, Oakland, Calif.



JUST ASK : MOST ANYBODY

While there is some chance that we might be prejudiced, our people believe that Layne well water systems are the very finest now being built. However, you can get your facts first hand by doing a little investigating of your own. Just ask most anybody who owns a Layne well water system if he considers them to be okay?—Are they low in upkeep cost—big in volume production—designed right—built of good stuff and then installed and serviced by people who seem to know their business?

We don't know exactly what kind of answers you will get, but according to past records, the "know how" boys,—operating engineers, plant managers, water works superintendents and cost accountants will be mighty, mighty complimentary. They are the first to recognize and show genuine appreciation of good equipment. A list of your nearby Layne well water system owners will be sent on request. For other helpful material—illustrated catalogs and folders, address

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A midget in size . . . a giant in safety, the GOLD MEDAL Midget Scaffolding Machine saves time and labor in refinery maintenance and construction.

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- **EASY TO OPERATE!** — Pinion gear for fast raising — worm gear for smooth lowering.

Bulletin J-7 (M) gives full information.
Write for your free copy.

A Complete Nation-Wide Scaffolding Service
based on seventy years experience in designing, making and supplying off-the-ground safety equipment assures you:
WHAT YOU NEED **WHERE** YOU NEED IT **WHEN** YOU NEED IT

GOLD MEDAL LADDER SCAFFOLDING — for Greater Safety...Efficiency...Economy
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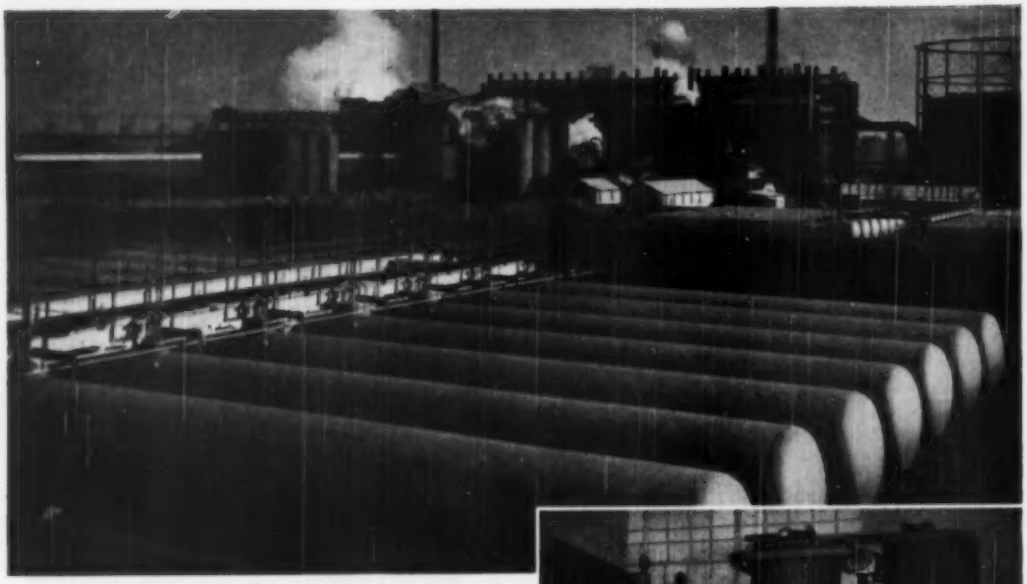
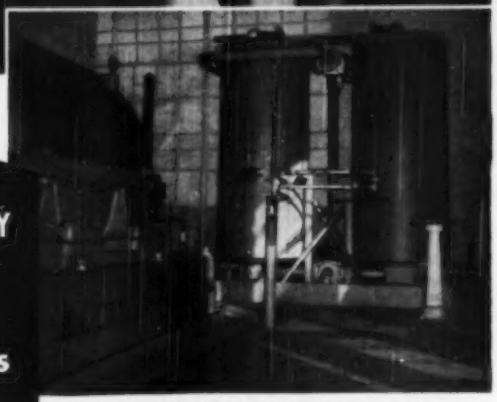


Butane is delivered to this tank farm by barges

THE BROOKLYN UNION GAS COMPANY *USES DRY GAS* to Pressurize Butane Tanks



This Lectrodryer dries manufactured gas used for unloading tank cars and for forcing butane into the system.

Thousands of gallons of butane are held in reserve here at the Greenpoint Works of The Brooklyn Union Gas Company, Brooklyn, New York. It is fed into the system in case of an emergency to supplement the regular supply of gas.

The butane is DRY when delivered, and the Company is careful to keep it that way. Manufactured gas used for forcing the butane out of the barge tanks in unloading, and again for forcing it into the vaporizing equipment, is dried by this Lectrodryer. Thus, there's no chance of moisture getting into the tanks.

Lectrodryers are performing equal service at many points in your industry—DRYing air, gases and organic liquids; preventing freeze-ups and contamination, helping to hold delicate chemical reactions on the beam and speeding up production.

Tell your troubles about moisture to Pittsburgh Lectrodryer Corporation, 307 32nd Street, Pittsburgh 30, Pennsylvania.

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LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

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...Use HOMESTEAD-REISER

FULL PORT Self-Sealed LUBRICATED PLUG VALVES

. . . the Lowest Priced, Full-Port-Area Plug Valves In Their Rated Working Class

If you're using a venturi (restricted-port-area) valve with an opening of say, 60% standard pipe area, you are operating at reduced line pressure. To be sure of nearly full line pressure, you must use a larger size venturi, which of course means a higher priced valve . . . perhaps as much as 30% higher!

For example: **A 2½" Homestead-Reiser has a 100% full-port-area, or 4.78 sq. in. The 2½" size in 60% venturi pattern has only 2.87 sq. in. port area. To approximate the full-port-area of a 2½" Homestead-Reiser valve, a 3" venturi must be used. And even then you'll have less than Homestead-Reiser's full-port-area.**

In the light of this evidence doesn't it stand to reason that Homestead-Reisers with their 100% full-port-area are sound economy?

Truly, from the standpoint of both first cost and length of service, they are the lowest priced, full-port-area lubricated plug valves in their rated working class!

(— For complete information, write for Catalog 39, Section 5. We'll mail it to you promptly.

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"Serving Since 1892"

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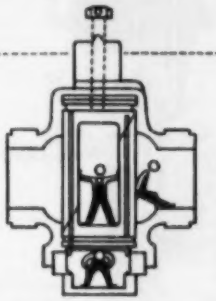

"SELF-SEALD" MEANS

. . . that in addition to a full-port lubricant seal the wedge-action of the plug under line pressure, forces the finished surfaces of the plug outward and constantly presses them against the seating surfaces of the body, thus keeping them always in intimate contact. The plug automatically adjusts itself for wear, assuring extra long life, maximum leakless service and lubricant economy.

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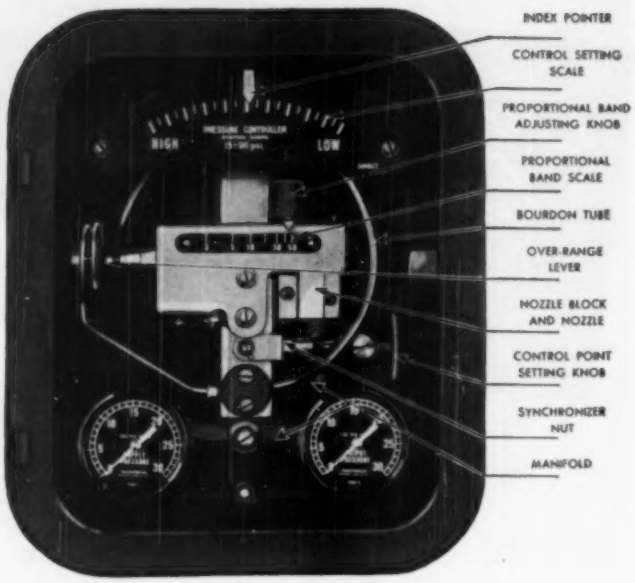
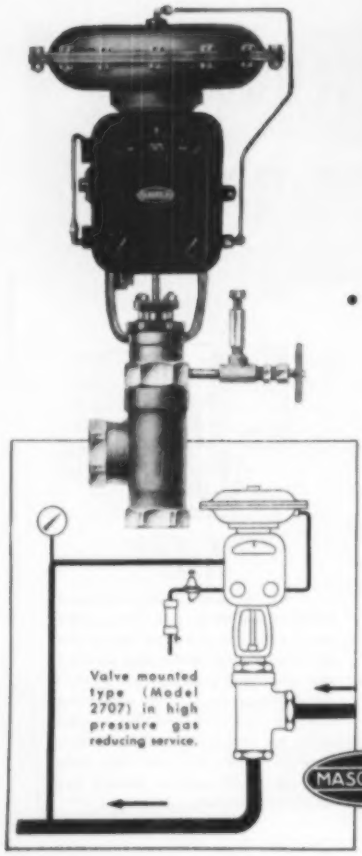
Ease of Adjustment





...yet is Moderately Priced

Masoneilan No. 2700 Pressure Controllers are especially designed for applications requiring accurate control when expensive instruments are not warranted. The pneumatic feedback, usually found only in more elaborate proportional controllers, assures precise response. The Control point setting mechanism provides accuracy of adjustment and easily read expanded index scale. Control action is reversible with either bourdon or bellows. The controllers are furnished in two case styles: a universal case for panel mounting; and a specially designed case for valve or wall surface mounting.

Applications include — pump governors, steam pressure reducing stations, gas well pressure reduction, and many others requiring small to intermediate proportional band.

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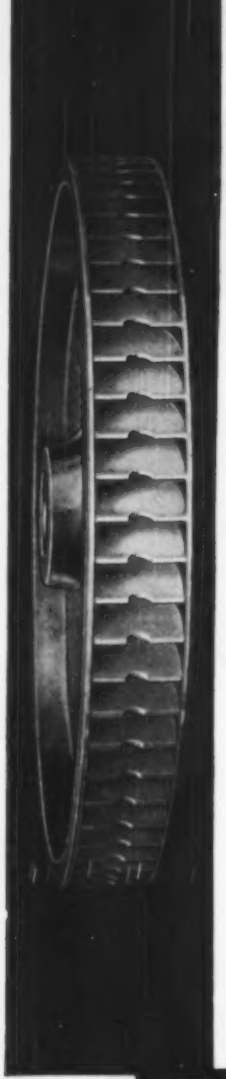
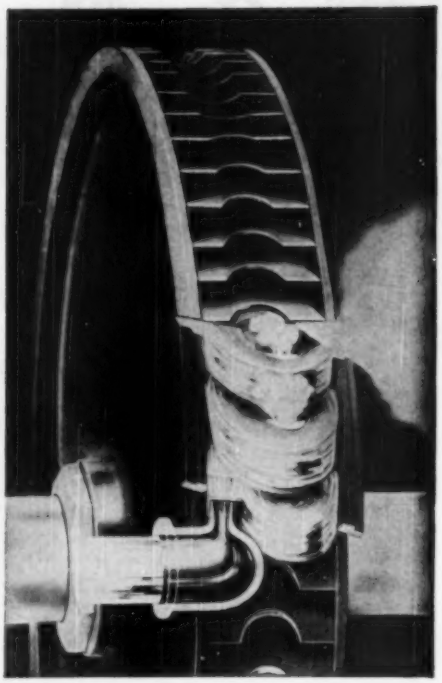




Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

NO PARTS TO LOOSEN OR WORK OUT

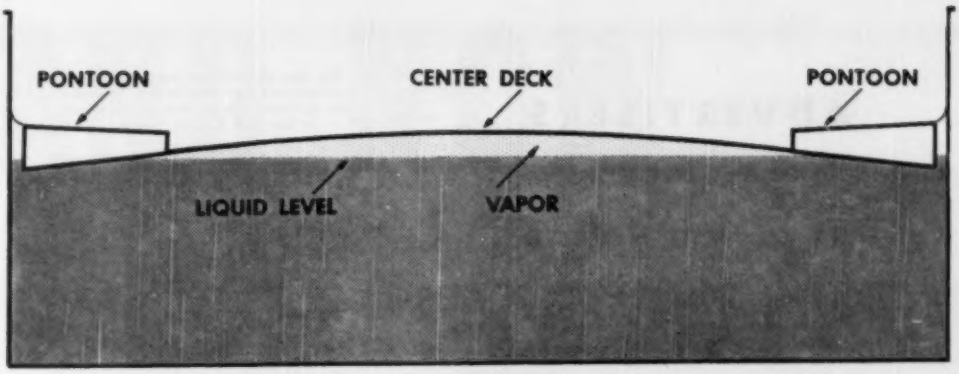
The rotor of the Terry Wheel Turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to become loose or work out.

The power-producing action of the steam takes place on the solid curved backs of these buckets or pockets. Therefore close clearance is unnecessary and wear on the blades forming the pockets is of little consequence, as it does not materially affect horsepower or efficiency.

For detailed information about this effective construction and its advantages, write us on your business letterhead for a copy of Terry Turbine Bulletin S-116.

T-1172

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.



Here's How the HORTON® Pontoon Roof Provides Protection Against Boiling Losses

The above sketch shows how the Horton Pontoon Roof gives you effective protection from evaporation losses due to boiling when it is installed in a flat-bottom tank storing crude oil, gasoline or similar petroleum products. The air space in the pontoon ring around the outer edge of the deck insulates the seal and the liquid under it. If boiling occurs, the vapor is trapped under the center section of the deck which domes upward, forming a blanket of vapor over the surface of the liquid. This serves as an effective insulating medium and prevents further boiling. When the temperature decreases, the vapor trapped under the center of the roof condenses.

Normally the entire bottom of the Horton Pontoon Roof rests directly on the liquid in the tank. The vapor space exists only when boiling occurs.

The Horton Pontoon Roof is effective in preventing evaporation losses caused by boiling even though the center section of the deck is of single thickness. The pan type of floating roof, with the entire deck of single thickness, is not recommended however for installations where boiling is encountered. When boiling occurs under a pan roof, vapor is not trapped under the deck but escapes at the rim.

Protection from evaporation losses caused by boiling is only one benefit provided by the Horton Pontoon Roof. It also cuts down corrosion, reduces the fire hazard, and reduces evaporation losses caused by breathing and filling. Write our nearest office for full details.

Below: 37,500-bbl. tank equipped with a Horton Pontoon Roof at the Esso Standard Oil Company refinery at Baton Rouge, La. This view shows the pontoon and single deck sections clearly.

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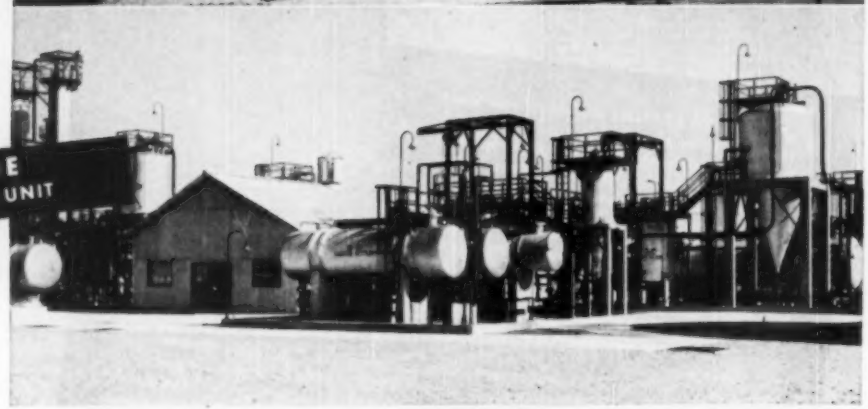

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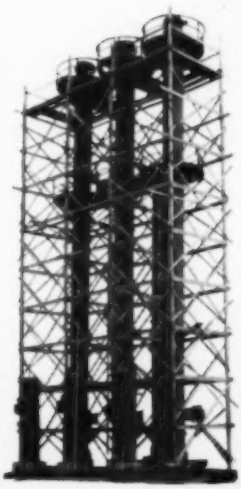

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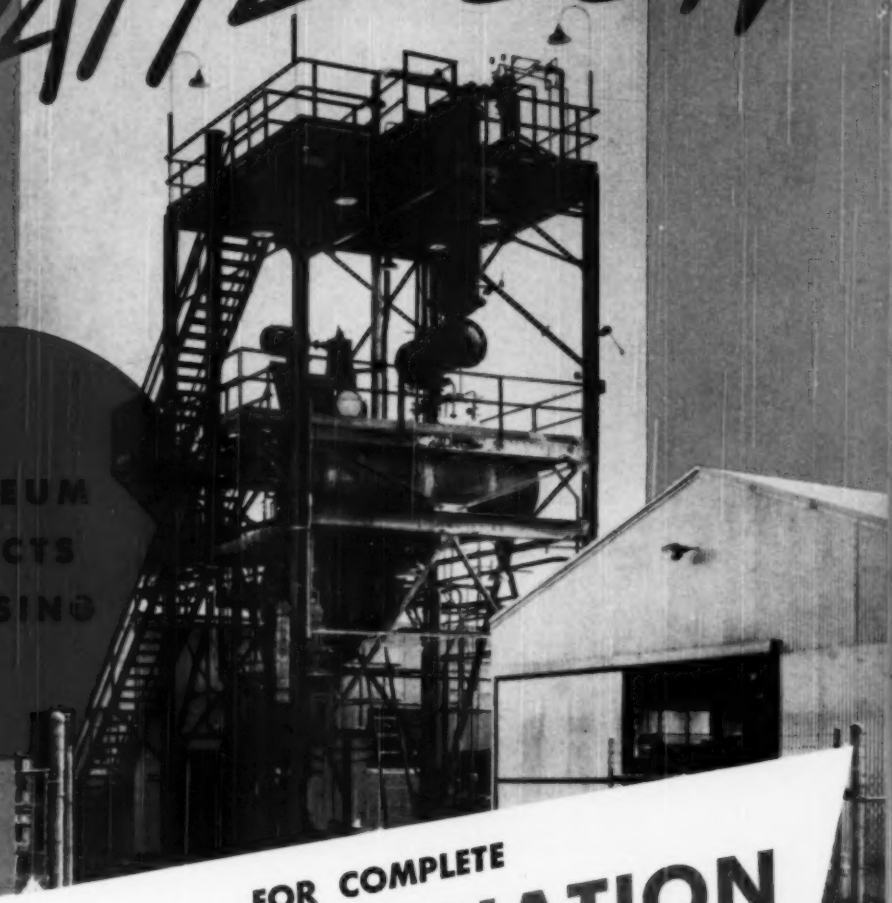

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